Fishery Data Series No. 25-55

Distribution and Migration Patterns of Coho Salmon in the Yukon River Drainage, 2022

by

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and

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November 2025

Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	′
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	″
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 25-55

DISTRIBUTION AND MIGRATION PATTERNS OF COHO SALMON IN THE YUKON RIVER DRAINAGE, 2022

by
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ABSTRACT

Coho salmon (*Oncorhynchus kisutch*) in the Yukon River support subsistence, personal use, sport, and commercial fisheries. However, fishery managers lack information about stock-specific run timing, spawning distribution, and relative abundance. To address the paucity of data, an exploratory radiotelemetry project was implemented on coho salmon in 2022. A total of 349 coho salmon were radiotagged in the lower part of the Yukon River near Russian Mission. The fish were tracked via a series of remote tracking stations and aerial tracking surveys. Major geographic areas were used to define broad drainage groups, which are useful for summarizing coho salmon telemetry results. The final location of each radiotagged coho salmon was assigned to 1 of 5 unique drainage groups, and basic summary statistics were produced from all fish assigned to each group. Most of the tagged coho salmon (53%) migrated to the Tanana River drainage with a mean migration rate of 34 km/day. The coho salmon bound for the Koyukuk River were the earliest, with a mean date of September 11, whereas for Tanana River stocks, the mean date was October 6. Migration rates slowed for fish entering spawning tributaries.

Keywords: coho salmon, *Oncorhynchus kisutch*, radio tag, radiotelemetry, Yukon River

INTRODUCTION

The subsistence fishery within the Yukon River drainage stands as one of the most extensive in Alaska (Fall et al. 2018). Across the Yukon Area, there are 43 communities, including approximately 2,900 households. Among these households, an estimated 1,400 engage in the annual harvesting of salmon for subsistence purposes (Padilla et al. 2024). Coho salmon (*Oncorhynchus kisutch*) plays a crucial role in ensuring food security, particularly during periods of diminished abundance of other salmon species, because they are the last to migrate into the Yukon River each season.

Over the period from 1995 to 2020, the average subsistence harvest in the Yukon Area was 17,129 coho salmon.[1] Recognizing the significance of subsistence fishing, the Alaska Board of Fisheries, in compliance with state statute, has affirmed the customary and traditional utilization of salmon in the Yukon Area. Quantities of harvest, known as the amounts necessary for subsistence (ANS), were established for each salmon species in the Yukon River, including coho salmon, to assess the management of subsistence fisheries (Brown and Jallen 2012). Coho salmon harvests have consistently fallen below the established ANS of 20,500–51,980 fish since 2005, except for 2012 (Padilla et al. 2024).

The largest annual coho salmon harvest occurs when commercial fisheries are operating within the Yukon River Delta. The average commercial harvest for the Yukon Area was 72,000 coho salmon from 2003 to 2019 (Gleason 2023), of which 80% was harvested in the lower Yukon Area. These commercial fishing activities adhered to the *Yukon River Coho Salmon Management Plan*.[2] This commercial fishery serves as a significant economic driver for rural communities, particularly those within the Yukon management area, providing essential income for both commercial and subsistence users alike. Consequently, a considerable portion of subsistence fishing households depend on supplementary earnings from commercial fishing to procure the materials and supplies essential for their subsistence harvesting activities (Wolfe and Spaeder 2009). An index of coho salmon abundance, excluding the harvests in the lower portion of the drainage below the tagging site, averaged ~200,000 fish (data on file with Bonnie M. Borba, ADF&G, Division of Commercial

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1 Arctic–Yukon–Kuskokwim Database Management System. 2006– . Yukon management area subsistence harvest data, Chinook salmon, 1992–2024. https://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareayukon.subsistence_salmon_harvest (cited July 8, 2024; accessed October 8, 2025).

2 Yukon River Coho Salmon Management Plan 5 AAC 05.368 (cited July 8, 2024; accessed October 8, 2025).

Fisheries, Arctic–Yukon–Kuskokwim Management Group, Fall Season Yukon Area Salmon Research Biologist, Fairbanks).

In 1992 and 1993, efforts were made to broaden the scope of the annual Yukon River subsistence salmon harvest survey to encompass Traditional Knowledge regarding coho salmon spawning locations (Holder and Hamner 1995, 1998). Through this initiative, subsistence users provided insights into previously unidentified coho salmon spawning streams, some of which have since been incorporated into the Anadromous Waters Catalog (AWC) database.[3]

Previous radiotagging studies have been conducted on summer chum salmon, a fish of similar size to coho salmon, and have successfully tracked them within the Yukon River drainage (Spencer and Eiler 2007; Larson et al. 2017). Limited investigations have been conducted regarding the distribution and run timing of coho salmon within the Yukon River drainage. Notably, in the Canadian segment of the Yukon River drainage, radiotelemetry studies were undertaken to document the distribution of coho salmon aggregations within the upper Porcupine River (EDI 2006 and 2008). Although these studies had a narrow scope, they served as a catalyst for future research endeavors and shed light on potential deficiencies in tracking coho salmon during the Arctic fall/winter seasons.

To address the paucity of knowledge about coho salmon in the Yukon River drainage, this study was designed as an initial large-scale effort to evaluate migration characteristics, map spawning distribution, and inform future research. This project was grant-funded by the Office of Subsistence Management, which supported the acquisition of tags, remote tower setup, field supplies, and 2 dedicated Alaska Department of Fish and Game (ADF&G) telemetry technicians. The Yukon Delta Fisheries Development Association provided funding for local boat captains. Furthermore, a U.S. Fish and Wildlife Service Yukon River Salmon Research and Management grant was used to augment tracking efforts within some spawning tributaries (Borba and Padilla 2023).

OBJECTIVES

The goal of this telemetry project was to gain knowledge of coho salmon migration, run timing, and estimated proportional contributions to major spawning tributaries throughout the Yukon River drainage, which are needed to sustainably manage coho salmon fisheries.

1. Summarize drainage group–specific mean migration rate between discrete sections of the mainstem, stock-specific mean run timing past the Russian Mission tag site, and distribution of tagged coho salmon.
2. Estimate proportional contributions of coho salmon returning to each of 5 drainage groups within the drainage such that the 95% confidence interval bounds will be no wider than 7% of the mean.
3. Identify migration routes and spawning areas within the Yukon River drainage and provide nominations to the Anadromous Waters Catalog to directly preserve habitat used by coho salmon.
4. Identify areas to add to the Yukon River coho salmon genetic baseline.

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3 Alaska Department of Fish and Game, Anadromous Waters Catalog overview. Available from https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=main.home (accessed October 8, 2025)

METHODS

STUDY AREA

The Yukon River flows over 3,190 km, draining approximately 855,000 km^2 of the interior of Alaska and Canada. The study area includes a portion of the Yukon River drainage within Alaska, from river kilometer (rkm) 340 (Russian Mission) to rkm 1,319 (mainstem Yukon River downstream of Rampart) and includes the Tanana River through rkm 1,694 (Figure 1). Current information on coho salmon distribution indicates that very few migrate into the upper Yukon River above the confluence with the Tanana River.

The tagging site was located in the community of Russian Mission. This location was upstream of the Andreafsky River (rkm 167), which has an average escapement of 8,000 coho salmon based on extended weir operations from 1995 to 2005 (Gewin 2006). However, several important geographic and fishery factors make the Russian Mission location ideal for tagging. The river near Russin Mission was confined to one relatively narrow channel, allowing for efficient capture of salmon for tagging (Figure 2). Farther inland, fall storms that create high winds and associated unsafe wave action are less likely to affect fishing operations. Additionally, in years when commercial fishing occurs, this location would be upriver from most of the commercial fleet, which reduces the harvest of tagged fish.

At the Russian Mission tagging site, a total of 3 fishing areas were evaluated (Figure 2). Site 1 was chosen for the operations of drift gillnets to implement tagging and release (Appendix A1). The remaining 2 sites were not used.

PROJECT DESIGN

Fish Capture

Local residents, knowledgeable about fishing areas, were contracted to assist with fish capture and tagging operations. The contracted locals, 2 captains, and 2 crew members were hired to operate 2 separate fishing vessels and assist biologists with tagging. Contractors were mentored in aspects of field logistics and tagging duties, and were also responsible for deploying, retrieving, and repairing fishing nets while operating skiffs in a safe manner. Each fishing vessel operated up to 7.5 hours per day, 7 days per week, for 4 weeks during the coho salmon run. Crews actively fished in 2 shifts: a morning crew operated from 8:00 AM to 2:00 PM, and the second crew operated from 3:00 PM until 9:00 PM. This schedule allowed daily tagging goals to be achieved, except for a few instances of adverse weather conditions. A combination of 2 to 3 Alaska Department of Fish and Game (ADF&G) and United States Fish and Wildlife Service (USFWS) personnel assisted the crew on each of the 2 boats, totaling 4 to 5 persons per boat. ADF&G or USFWS personnel were on site and responsible for training staff to ensure fish were properly handled, tagged, and released to minimize handling effects, as well as overseeing data collection and processing.

Drifting methods followed those used in the feasibility study conducted by Spencer and Eiler (2007). Fish capture gear used 2 different types of gillnets. Gillnets of 5.5-inch and 6.0-inch mesh, 20 fathoms in length, 7.6 m in depth, hung at a 2:1 ratio, and constructed of #9 cable laid netting, were used for most of the fish-capturing drifts. All fish were removed from the net and their condition inspected before being released or processed. A dip net was used to transfer a maximum of 2 coho salmon per drift directly to the project boat for processing. The selected coho salmon were further evaluated for condition, and only those with no major wounds or bleeding injuries were selected for tagging. Nontarget fish and additional coho salmon were released alive without being brought onto the boat. If any fish were severely wounded, they were kept and distributed to local communities for subsistence use.

Tagging Methods and Catch Data

To ensure the coho salmon were tagged in proportion to the magnitude and timing of the run, a 4-week radiotagging schedule (Borba and Padilla 2022) was developed using historical run timing from the Mountain Village fall drift gillnet test fishery project (Sandone 2017). This schedule was expected to cover the central 80% of the run. Inseason run timing information from the fall operations of a combination of assessment projects, including the lower Yukon River test fishery in Emmonak, the drift gillnet test fishery in Mt. Village, and sonar operations near Pilot Station, were used to modify the deployment schedule as needed.

A total of 350 coho salmon were to be fitted with radio tags and secondary marks. The sample size was based on the estimated run size and resolution needed for the 5 drainage groups selected to fulfill Objective 2 (Bromaghin 1993). Once a fish was selected for tagging, it was placed in a cradle submerged in an onboard water tank. The water tank was continuously resupplied with fresh river water using a 12-volt battery-powered bilge pump. When more than 1 fish was selected for tagging, it was also held in the same onboard flow-through water tank outside the cradle. All fish were handled as gently as possible to minimize stress (Baker et al. 2013), and handling was expected to be less than 2 minutes per fish.

Each fish was double tagged. An external mark, a unique and sequentially numbered spaghetti tag,[4] was sewn through the musculature at the base of the dorsal fin of each fish. Then the fish was tagged with a pulse-coded esophageal radio transmitter.[5] Because adult salmon do not feed during their spawning migration, tags were applied through the mouth, seating the tag in the stomach using a plastic applicator that was one-quarter inch in diameter and approximately 9 inches long. Each transmitter emitted a unique frequency-code combination, allowing identification of individual fish. In addition, transmitters contained motion sensors; if a fish became inactive for more than 24 hours, the tag would emit an inactive signal. Transmitters had a minimum battery life of 245 days. All tagged fish were released back into the water over the outside edge of the boat immediately after sampling.

The radiotagging crew recorded fishing effort and catch data for each drift. The total number of all other nontargeted fish species caught was recorded, along with the number of untagged coho salmon released. For each radiotagged coho salmon, the following was recorded: the degree of coloration, visible healed scars, sex based on external characteristics, mid eye to fork of tail length (measured to the nearest millimeter), external tag number, radio tag frequency and code, name of the person tagging the fish, latitude, longitude, date and time of release, and qualitative comments about the fish. External tag numbers from any coho salmon recaptured at the tag site would also be recorded. Capture and tagging data were edited and entered daily into a Microsoft Access database and sent electronically to Fairbanks for the database manager to upload and incorporate with data from the remote tracking stations (RTS). All tagged fish were used for analyses of sex and length.

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4 Floy Tag model FT-4 (12 inches long).

5 Advanced Telemetry Systems model F1840B. 150–151 MHz frequency range. 5.6 cm long, 1.7 cm in diameter, and 22 g in weight.

Remote Tracking Stations

An array of RTS located throughout the Yukon River drainage (Eiler et al. 2004) was used to track upstream movement of tagged coho salmon. A total of 11 RTS were activated within the study area and were located along important salmon migration corridors and large tributaries within the Yukon River drainage (Figure 1; Appendix A4). The first RTS was located approximately rkm 61 upstream of the tagging site and hereafter referred to as Paimiut station. The first upstream RTS was used to determine which tagged fish successfully moved upstream after tagging.

The tracking stations consisted of several integrated components attached to a Vaisala model 404A portable remote automatic weather station tower. Components of the RTS included an Advanced Telemetry Systems computer-controlled receiver/datalogger model R4500C, Yagi model 443A transmitting antenna, an ATS RDP1000 (Remote Data Platform) transmitter, a self-contained power system consisting of 2 Kyocera model KC80 solar panels, and 6 Concorde Battery Corporation model PVX-2240T AGM batteries. The RTS were positioned to achieve the best reception and fish detection range and were primarily located on bluffs overlooking straight, narrow, single-channel sections of the river.

Each RTS recorded both downstream and upstream movements of radiotagged salmon (Eiler 1995). Radiotagged fish within reception range of the RTS were identified by the signal being transmitted and recorded. Information collected included: the date and time the fish was present at the site, the signal strength and activity pattern of the transmitter (active or inactive), and the location of the fish in relation to the station (i.e., upriver or downriver from the site). Information on station operations (i.e., voltage levels for the station components, and whether the reference transmitter at the site was being properly recorded) was also collected. The accumulated telemetry data was transmitted every hour from the RDPs on the remote towers to an Iridium satellite network RUDIC data service uplink (Borba and Padilla 2022). ATS downloaded encrypted data hourly and sent translated data to an assigned ADF&G email address in Fairbanks, where data were automatically uploaded into a database for analysis. A dashboard was also developed using Environmental Systems Research Institute (ESRI)[6] software providing inseason monitoring (updated hourly) of tagged fish movements as they passed each RTS, including locations after each aerial tracking event.

Drainage Groups

The Yukon River was cordoned off into 5 drainage groups by activating 6 RTS at the following locations: upstream of tagging site (Paimiut station), mainstem Yukon River upstream of Anvik, lower Koyukuk River mainstem near Koyukuk, mainstem Yukon River near Yuki River (between Galena and Ruby), lower Tanana River mainstem downstream of Manley, and upper mainstem Yukon River downstream of Rampart. The RTS near Rampart was used to define the uppermost section of the Yukon River. To further assess potential spawning tributaries on larger secondary river systems, 5 RTS were activated in the Anvik, Innoko, Nowitna, Kantishna, and Tanana Rivers, upstream of the community of Nenana (Figure 1).

The 5 drainage groups of interest were thought to cover the majority of the coho salmon migration and spawning habitat in the U.S. portion of the Yukon River. The first group consisted of all the waters between the Paimiut, lower Koyukuk, and mainstem Yuki RTS, including the major

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[6] Skinner, A. 2017. A restructured 'Terrain with Labels' Vector Basemap. https://www.esri.com/arcgis-blog/products/mapping/mapping/a-restructured-terrain-with-labels-vector-basemap/ (cited May 4, 2023; accessed October 6, 2025).

tributaries of the Innoko and Anvik Rivers. The second group consisted of all waters between the mainstem Yuki, Raven Ridge, and Manley RTS, including the major tributary of the Nowitna River drainage. All the waters within the Koyukuk (upstream of the lower Koyukuk RTS) and Tanana (upstream of the Manley RTS) river drainages were each designated as separate groups. The final group included all waters upstream of Raven Ridge tower to the U.S./Canada border (Figure 1; Appendix A4).

Aerial Tracking

Aerial surveys were used to gain further insight into migration routes, locate spawning areas, and determine the final fates of radiotagged fish. Tagged salmon were located from fixed-wing or rotary-wing aircraft equipped with 4-element Yagi-type receiving antennas. Aerial surveys were generally flown 1,000 feet above ground, depending on weather conditions and topography. When a biologist was aboard, flights were flown at a lower altitude for visual confirmation of salmon presence. Mainstem Yukon River flights were bank-oriented, whereas the tributary flights were flown up the center of the system. Survey flight routes were determined by analyzing passage records from RTS using a dashboard that tallied the number of fish that had passed each RTS. After each survey flight, data were uploaded to the database to identify fish that were accounted for within the surveyed area. Efforts early in the season were concentrated on the Yukon River mainstem to track fish as they migrated upriver. Searches within the tributaries began in the lower river due to the anticipated timing of spawning as fish move upriver. Tags located near villages or fish camps were further investigated by circling with aircraft to increase location accuracy.

To locate tagged coho salmon, 15 aerial tracking events occurred between September 6 and November 29. Flights covering the mainstem Yukon River occurred on September 6 and September 19 to track the fish as they spread throughout the study area. Subsequent tracking, including 4 boat surveys of the Delta Clearwater River (DCR; also known as Delta Clearwater Creek on most USGS maps), occurred within the tributary between September 27 and November 29 (Appendix A5).

DATA ANALYSIS

Data Reduction

As each tagged fish approached an RTS, the receiver recorded and stored the unique frequency and code, signal strength, and time stamp. Stored data was transmitted to a SQL Server database. Data processing continued using a Microsoft Access database and *R* to achieve summarization. Summarized data were used to assign a fate to all radiotagged coho salmon, based on cumulative information from tag returns, RTS, and aerial surveys. Each tagged fish was assigned 1 of 9 predefined fates, as follows:

1. Spawner – a fish located in a tributary of the Yukon River.
2. Subsistence mortality – a fish known to be harvested in the subsistence fishery.
3. Commercial mortality – a fish harvested in the commercial fishery.
4. Personal use mortality – a fish harvested in the personal use fishery.
5. Sport fish mortality – a fish harvested in the sport fishery.
6. Suspected harvest – a fish thought to be harvested but was not reported; based on extreme rates of travel or proximity to community or fish camp.

7. Upstream migrant – a fish that migrates above the RTS located at Paimiut that was never found again.
8. Failure – a fish that was never located or never migrated upstream of the capture site, which includes transmitters that were regurgitated or malfunctioned.
9. Non-terminal areas – which include fish that remain in the Yukon River mainstem and its sloughs.

Several factors contributed to determining the final fate of each fish. Queries of this large database were used to summarize data on run timing to the prevalent spawning locations, migration rates, and proportion of spawners located in important spawning areas, taking into account harvests along the route. Very few tags were anticipated to be harvested due to salmon fishery restrictions and closures in place to conserve Chinook and chum salmon stocks during this tagging year. Fish designated as spawners were included in analyses for run timing, migration rates, and distribution.

Simple proportions of radiotagged fish assigned to each fate were calculated. Run timing statistics were calculated for the sample of radiotagged fish that moved successfully upstream after tagging. This information was used to identify important spawning areas, estimate migration rates, and run timing profiles.

Catch Per Unit Effort

Efforts were made to deploy tags each day in proportion to run abundance. Daily catch per unit effort (CPUE) was calculated and graphed alongside daily tag deployment and coho salmon abundance estimated by the nearby Pilot Station sonar (rkm 198; Morrill et al. 2023). Visual comparisons were made to examine how closely daily tag deployments were to other daily run strength measures across all temporal components of the run.

The coho salmon catch for each drift was converted to a drift CPUE (i.e., number of coho salmon caught per fathom hour).

Denoted that:

i = fishing date.

m = mesh size (5.5, or 6.0 in stretch mesh).

$f_{i,m}$ = net length.

$t1_{i,m}$ = time of starting net deployment.

$t2_{i,m}$ = time of net fully deployed.

$t3_{i,m}$ = time of starting net retrieval.

$t4_{i,m}$ = time of net fully retrieved.

$C_{i,m}$ = the number of coho salmon caught in each drift.

For each drift, the mean fishing time will be calculated as:

$$\bar{T}_{i,m} = \frac{1}{2}\left(t3_{i,m} + t4_{i,m} - t2_{i,m} - t1_{i,m}\right), \quad (1)$$

and its standardized drift CPUE ($I_{i,m}$) per fathom net length and hour of fishing effort was calculated as:

$$I_{i,m} = \frac{c_{i,m}}{f_{i,m} \cdot \bar{T}_{i,m}}. \quad (2)$$

To provide an estimate of relative abundance of coho salmon passing the tagging sites, a daily CPUE(I_i) was calculated as:

$$I_i = \sum I_{i,m} . \quad (3)$$

Distribution and Proportion of Drainage Group

The estimate of drainage group proportion $\hat{P}_j$ was calculated as:

$$\hat{P}_j = \frac{n_j}{\sum_{j=1}^{5} n_j}, \quad (4)$$

where n_j is the number of fish assigned to the jth drainage group (j = 1, 2, …,5).

Migration Rate

The migration rate for each fish $\hat{S}_j$ between RTS was estimated as:

$$\hat{S}_j = \frac{l_j}{d_j}, \quad (5)$$

where l_j is the distance (km) between any 2 RTS representing the river section (j), and d_j is the number of days that it took a tagged fish to migrate between 2 towers.

Mean and 95% CI of migration rate were calculated for each drainage group for fish fates designated as spawners. Analyses of variance (ANOVA) and Tukey's honest significant difference test (Tukey HSD) were used to examine the differences in mean migration rates among the 5 drainage groups.

Drainage Group-Specific Run Timing

Mean and 95% CI of tagging date and rate were calculated for each drainage group for fish fates designated as spawners. ANOVA and Tukey HSD were used to examine differences in mean migration dates among the 5 drainage groups.

NOMINATIONS TO THE ANADROMOUS WATERS CATALOG

The final locations of tagged fish tracked into tributaries were compared to coho salmon data documented in the ADF&G's AWC. All tagged fish that entered streams not previously recognized as coho salmon habitat in the AWC were identified. New migratory, presence, or spawning locations and extensions of ranges determined from this project were submitted to the ADF&G Division of Habitat for nomination for inclusion within the AWC. Any nominations not accepted during review were retained for future consideration.

RESULTS

FISH CAPTURE AND TAGGING

Field operations directed at capturing and tagging coho salmon began in mid-August. Initial fishing site selection, snag net operations, and tag application training occurred from August 12 to August 14, 2022. Coho salmon capture and tagging operations occurred from August 15 to September 5. On August 25, fishing operations were canceled for the day due to inclement weather.

Tag deployment appeared to be reasonably proportional to fish abundance, and all major temporal components of the run were represented. Daily CPUE ranged from 0.10 fish per fathom-hour on August 17 to 0.57 fish per fathom-hour on September 4 (Appendix A2). The daily CPUE at the tagging project related to the daily passage estimates for coho salmon at Pilot Station sonar because they both fluctuated as each major group passed (Appendix A2).

A total of 424 coho salmon were handled, including 349 tagged, 49 released live, and 26 kept and donated to the community due to injuries (Table 1). The tagged fish exhibited 88% light, 11% dark, and 1% silver coloring. The average handling time was 1 minute 27 seconds, and there were no instances of recaptured tagged fish.

Fish tagged in this study appeared to be representative of the Yukon River coho salmon population. Tagged coho salmon consisted of 224 males (65%) and 123 females (35%), and sex was not determined for 2 fish. Mean length of tagged coho salmon was 525 mm for males and 536 mm for females ($p < 0.00$). The smallest coho salmon tagged was a female of 445 mm in length (Figure 3). Length frequency distributions between tagged coho salmon in this project and those sampled at the test fishery operated for apportionment at the mainstem Yukon River sonar operated near Pilot Station were comparable (Kolmogorov-Smirnov test; $D = 0.11$, $p = 1.00$; Appendix A3). Comparisons of sex-specific length distributions between locations revealed no significant differences (Kolmogorov-Smirnov test; male: $D = 0.05$, $p = 0.99$; female: $D = 0.06$, $p = 0.92$).

Additional species handled during fishing operations included 167 chum salmon *Oncorhynchus keta*, and 83 whitefish, of which 16 *Coregonus* spp. and 8 *Prosopium cylindraceum* were donated to the community. Fish released from the nets also included 12 longnose suckers *Catostomus catostomus*, 5 sheefish *Stenodus leucichthys*, 1 Dolly Varden *Salvelinus malma*, 1 Chinook salmon *O. tshawytscha*, and 2 unidentified species.

TAG FATES AND FISH TRACKING

Out of the 349 tagged coho salmon released, 3 were assigned the fate of suspected harvest, 5 were assigned a fate of upstream migrant because they migrated above the first tower at Paimiut and were never located again, and 23 were assigned failure because they never migrated above the first tower (Table 2; Figure 4). These 28 fish were excluded from further analysis. The remaining 318 fish were included in the analysis of tagged fish moving into the primary study area. A total of 248 fish (71%) were assigned the fate of spawner because they were located within tributaries off the mainstem Yukon River. The remaining 71 (20%) fish were assigned the fate of non-terminal areas because they were last located in the mainstem Yukon River, including sloughs.

DISTRIBUTION

Relative contributions of coho salmon among the 5 drainage groups that were designated as spawners ($n = 248$) included 53% to the Tanana River, 34% within the Paimiut to mainstem Yuki tower area, 7% within the Koyukuk River, and 6% remained within the mainstem Yuki to Upper Yukon area (Table 3 and Figure 5). The proportional contribution estimates of coho salmon returning to these 4 drainage groups have 95% confidence interval bounds no wider than 7% of the mean (Table 3). The fifth group was the upper Yukon; however, only 1 fish entered that section, precluding meaningful analyses of run timing and migration rate statistics (Figures 6–7).

Although this study primarily focused on the mainstem Yukon River tracking data to assign fish to drainage groups, aerial surveys were also used to track within some tributaries. The aerial coverage between Paimiut and mainstem Yukon near Yuki towers (lower Yukon River) showed a wide distribution of tagged coho salmon entering first-order through fifth-order streams (classic stream order) along the right bank of the Yukon River (Figure 8). In the middle mainstem section, from Yuki tower upstream to Upper Yukon area, several coho salmon were located within the headwaters of the Yuki and Tozitna Rivers (Figure 9). Koyukuk River drainage aerial surveys were conducted the latest in November (Appendix A5), where coho salmon were distributed in the headwaters of the Huslia River drainage as well as within tributaries of the Hogatza River (Figure 10). Within the Tanana River drainage, radiotagged coho salmon were distributed throughout the Kantishna River drainage, the Nenana River drainage, and were mostly located in left bank tributaries of the upper Tanana River drainage from Kiana Creek to the DCR (Figure 11).

RUN TIMING AND MIGRATION RATES

Run timing was variable among the drainage groups of coho salmon. Mean run timing for the Koyukuk River drainage group was the earliest, occurring on September 11. The lower drainage group between Paimiut and Yuki towers had a mean run timing of October 2 (Table 4). The coho salmon designated as spawners within the Tanana River drainage group had a mean run timing of October 6, and the fish were present throughout the run. The Yuki to Upper Yukon tower drainage group had the latest timing of October 24. Mean run timing of those fish designated as spawners was significantly different (ANOVA, $F(3, 244) = 12.98$, $p < 0.01$). Using Tukey HSD for further investigation, all combinations were significant ($p < 0.03$) except fish traveling up the mainstem Yukon River to the Tanana River (between Paimiut and the Tanana drainage group, $p < 0.06$; and the mainstem Yuki to the Tanana drainage group, $p < 0.36$).

The migration rate, upriver from the Paimiut tower, varied among the drainage groups of coho salmon. Mean migration rate was the highest for the Koyukuk River group, with a mean of 34.9 km/day. Fish moving into the upper mainstem portion of the study area traveled a mean of 32.6 km/day. Coho salmon bound for the Tanana River traveled a mean of 34.0 km/day. Fish bound for the lower mainstem portion of the study area between Paimiut and Yuki towers traveled a mean of 26.7 km/day (Table 4). Mean migration rates were significantly different between groups (ANOVA, $F(2,221) = 15.55$, $p < 0.00$). The mean migration rate of those fish designated as spawners, traveling from the Paimiut to the mainstem Yuki towers, was significantly slower than that of fish within the middle Yukon River mainstem between Yuki and upper Yukon towers (Tukey HSD, $p < 0.02$). Likewise, they were also significantly slower than fish in the Koyukuk (Tukey HSD, $p < 0.00$) or Tanana drainage groups (Tukey HSD, $p < 0.00$). Movement of fish within each drainage group, as designated by the towers and flights, showed a marked decrease in migration rates later in their migration (Figure 12).

Mean migration rate through discrete sections of the Yukon River drainage was not consistent. The peak mean migration rate (39.1 km/day) for coho salmon occurred between the Paimiut tower and the mainstem Yukon River Anvik tower (Table 5). Migration rates slightly decreased upstream of the mainstem Anvik tower (200 kilometers), after which migration rates remained relatively consistent on the mainstem Yukon River (~34 km/day). Migration rates slowed once fish entered tributaries. Fish entering the Anvik River had the lowest migration rate (16.4 km/day). For the Tanana River, fish entered at a mean of 36.5 km/day (Manley tower) and slowed to 29.4 km/day at the Nenana tower. Fish entering the Tanana River and traveling to the Kantishna River migrated at a mean of 31.5 km/day (Table 5; Figure 13).

Anadromous Waters Catalog

A total of 67 tagged coho salmon traveled to previously undocumented areas, resulting in 19 additions to the AWC (Table 6). The revisions included adding new species to 9 existing streams (4 with upstream extensions), adding new species in 6 new streams, adding new life stages to 3 existing streams, and extending the upper reach of a stream for coho salmon. Supplementary documentation provided supporting information for coho salmon in 35 existing AWC streams and 2 non-AWC water bodies. However, the findings for non-AWC water bodies will need further documentation to meet the minimum requirements for nominations.

Genetic Baseline

The results of this project were used to develop recommendations for future sampling efforts (Table 7). The current state of the coho salmon genetic baseline was compared to this project's findings, and the highest priority gaps included the Tozitna and Yuki Rivers in the middle Yukon River. Additionally, some existing populations in the baseline have inadequate sample sizes; those that are more easily accessible, such as the Kaltag River, were prioritized for higher consideration.

The second highest priority included an area with partial samples, which are harder to access, specifically Clear Creek within the Hogatza River drainage. The Huslia River drainage upstream to Billy Hawk Creek would also be a good source to represent the Koyukuk River drainage. The Toklat River drainage was identified to supplement the existing Kantishna River drainage samples.

Third-priority streams included some representative systems in the lower Yukon River drainage and the Delta Clearwater River (Tanana River drainage), which are currently in the baseline and could benefit from additional sampling. The Richardson Clearwater was identified as accessible and would be supplemental to Tanana River populations. Fourth-priority streams included newly identified lower river populations, such as the Bonasila River and Thompson Creek. These locations were designated as such due to logistical difficulties and existing representation by other lower river samples. The Gisasa River was a new site selected to supplement the Koyukuk River drainage, but it was a lower priority based on the numbers identified in the system. Fifth-priority streams mostly had sufficient samples and are not required at this time due to closely related population structures (e.g., within the Nenana River drainage).

Samples within the Canadian portion of the Porcupine River drainage, the farthest upstream known distribution of coho salmon, are also difficult to obtain, and current samples are from juvenile coho salmon, where adult samples would complement the collections. Recent collections in the U.S. portion of the Kevinjik Creek will also supplement the baseline in this northernmost extent.

DISCUSSION

Tagging

Test fishing began on August 12; the first fish encountered were fall chum salmon, and the first coho salmon was captured on August 15. Test fishing was delayed by 2 days because it was necessary to relocate operations to a new field camp. Nonetheless, the project began capturing coho salmon before the first large group passed the location. During this portion of the run, male coho salmon constituted 97% of the tags released in the initial 3 days. The proportion of females totaled 35% in the tagged sample and aligned with 2 downstream test fisheries using internal sex identification (41% females). Additionally, 3 test fisheries downstream of the project indicated that coho salmon run timing was later than average (Gleason et al. 2023). Adverse weather conditions on August 25 disrupted both fishing and tagging operations. Subsequently, tags were rescheduled for deployment accordingly. Tag deployment in the latter part of the run deviated from the tagging schedule. On September 2, a total of 37 tags were deployed, which resulted in compressed coverage of the last group of fish (Appendices A1 and A2). Additionally, on August 27, a single tag was discovered to be nonfunctional during pre-insertion testing. Notably, the average handling time during tagging was less than 2 minutes.

From 1998 to 2019, the mean length of coho salmon captured in the test fishery at the mainstem sonar near Pilot Station was 563 mm. However, over the recent 3 years (2020–2022), the average decreased to 519 mm (AYKDBMS).[7] The selection of tag size for this project was informed by historical data predating the recent decline in length, which coincided with the 3 lowest returns on record based on the run size index (Ransbury et al. 2022). Consequently, to ensure tags fit, a few smaller coho salmon were selectively omitted from tagging and safely released back into the water alive (Appendix A3).

FISH TRACKING

Originally, 13 RTS were scheduled to be prepared for this project; however, 2 were excluded. The proposed RTS located in the Russian Mission was removed due to its proximity to the new tagging site. The second gateway tower at the Paimiut RTS location was not set up due to limited hardware and redundancy. In addition, an RTS was scheduled to be installed on the Nulato River; however, land-use permits were not received prior to the project's start date. Thus, an RTS was installed on the Kantishna River in the Tanana River drainage. This decision aimed to enhance the project's scope by extending coverage to encompass this expansive river system. An additional RTS was activated by USFWS on the lower Porcupine River (rkm 1,515; lat 66.970 N, long -142.760 W); however, no tags were detected passing this location. Unfortunately, the Paimiut station RTS transmitter encountered installation issues, resulting in a 2-day delay in tracking and incomplete detection of fish migration past the tower. As a result, 63 coho salmon were not detected past the Paimiut tower, and 5 were not detected past the mainstem Yukon tower near Anvik but were confirmed by observations at subsequent upstream towers. Consequently, the calculation of timing between towers was more limited. The issues with these towers, such as potential misalignment of antennas or inadequate gain settings, may have contributed to the failure to detect fish located farther across the river or at depth.

The Koyukuk RTS also experienced battery maintenance and transmission issues after tagging began and had to be revisited. On the day the tower became operational (August 27), a fish was detected immediately, which suggests the possibility of undetected fish. The fish observed was from the first day of tagging; therefore, additional undetected fish were expected to be minimal.

Previous studies have suggested that salmon can successfully migrate to spawning grounds using internal esophageal tags (Eiler 2004; Larson et al. 2017). In this study, 93% of the tagged coho salmon passed upriver of the first RTS. Tag failures (i.e., a fish that was never located or regurgitated a tag) were spread throughout time and could not be attributed to fish length, sex, or tagger. Of the 23 failures, 1 was located approximately 6 km below the tagging site and was suspected of being a regurgitation, and 1 was located approximately 50 km downstream. Some of

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[7] Arctic–Yukon–Kuskokwim Database Management System (AYKDBMS). 2006– . Alaska Department of Fish and Game, Division of Commercial Fisheries. Juneau, AK. https://www.adfg.alaska.gov/CF_R3/external/sites/aykdbms_website/Default.aspx (accessed October 8, 2025).

the fish not seen after release could have migrated back to the Andreafsky River, but this was not confirmed because the aerial survey flight on August 29 was unable to cover the system due to inclement weather in that specific area.

The radio tags were designed to have a battery life of 240 days.[8] However, after 67 days of tag deployment, aerial survey crews began documenting undecoded fish (October 21). Despite numerous attempts to troubleshoot the receivers, it was concluded that premature battery failure was likely the cause. The manufacturer was notified, and after the project was completed, 1 undeployed tag was returned for examination. Subsequently, the batteries in the radio tags were confirmed as the cause of the issue. Fish that were detected but not decoded did not have enough information to be assigned to a specific fish. However, the observed congregations of fish, particularly in the Koyukuk River drainage, were consistent with spawning behavior.

None of the new AWC nominations were accepted under the category of spawning; instead, they were listed as present. Many of the aerial surveys were conducted without a biologist on board, and those that were manned occurred late in the season. These late-season surveys posed challenges in observing fish on redds from the air, primarily due to the angle of light with the landscape covered in snow. As a result, water bodies appeared black, making it difficult to see the substrate.

CONCLUSIONS

The project successfully met all objectives, despite issues with radio-tag battery life and the installation of radio tower equipment. Valuable insights were gained into additional spawning locations beyond the more accessible and known Tanana River coho salmon. Similar to the summer chum salmon study (Larson et. al 2017), the fish traveling to the Koyukuk River had the earliest run timing. Due to severe fishery closures in the year of tagging (2022; Gleason et al. 2023), there was minimal exploitation, which reduced the potential removal of tagged fish throughout the drainage. Further, the study revealed that the migration rates of coho salmon decreased as they approached spawning areas, a behavior consistent with observations in other salmon species (Eiler et al. 2004). These findings collectively contribute to a better understanding of coho salmon behavior and dynamics within the Yukon River drainage.

RECOMMENDATIONS

This coho salmon radiotagging project served as a 1-year feasibility study, highlighting the need for additional years (2–3) to account for interannual variability of run characteristics. The operations of this project focused on the main portion of the run, which spanned 4 weeks of the typically 6-week duration. Hence, it is recommended to extend the project duration to encompass more of the run in the future. Securing funding for salmon species projects on the Yukon River, other than Chinook salmon, has proven challenging over the last 2 decades. The Yukon River remote tower infrastructure reactivated for this project laid the groundwork for subsequent projects, such as the current Chinook salmon telemetry project (JTC 2024). Leveraging the existing infrastructure for future coho salmon tagging initiatives would offer significant cost savings and operational efficiencies.

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[8] Advanced Telemetry Systems. 2023. Fish implant series F1800 specification sheet. Download PDF from: https://atstrack.com/assets/documents/series/seriesPDF/F1800.PDF

DATA ACCESSIBILITY

Primary data, including raw fish capture data, are stored in a SQL Server database at the Alaska Department of Fish and Game, Division of Commercial Fisheries, Data Resource Management, Anchorage, Alaska 99518. All tower and aerial tracking downloads are also stored in this database. Data files for this report have been archived at the Alaska Department of Fish and Game, and all data requests go through the AYK Regional Research Coordinator.

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TABLES AND FIGURES

Table 1.–Number of coho salmon captured, released alive, donated, or tagged near Russian Mission, Yukon River, 2022.

Disposition	Number of fish	Percent
Released alive	49	11.6
Kept and donated	26	6.1
Tagged	349	82.3
Total captured	424	100.0

Table 2.–Final fates of coho captured and tagged near Russian Mission, Yukon River, 2022.

Fate description	Number of fish	Percent
Spawner	248	71.1
Non-terminal	70	20.1
Failure	23	6.6
Upstream migrant	5	1.4
Inferred harvest	3	0.9
Total tagged	349	100.0

Table 3.–Number and percentage of coho salmon final locations by drainage group, Yukon River, 2022.

Drainage group	n	Percent	SE	95% CI (±)
Paimiut to MS at Yuki River	83	33.5	0.03	0.06
MS at Yuki to Upper Yukon	15	6.0	0.02	0.03
Koyukuk River	18	7.3	0.02	0.03
Tanana River	132	53.2	0.03	0.06
Upper Yukon	NA	NA	NA	NA
Total	248	100%		

Note: Only includes fish fates designated as spawner. Proportion to each drainage group includes a 95% confidence interval (95% CI). MS means mainstem Yukon River. NA means not applicable.

Table 4.–Characteristics of run timing for coho salmon captured near Russian Mission, Yukon River, and tracked to designated drainage groups, 2022.

Drainage group	n	Date first fish	Date last fish	Duration (days)	Mean date	Mean km/day	SE	95% CI (±)
Paimiut to MS at Yuki River	83	8/26	10/28	63.1	10/2	26.7	1.1	24.6
MS at Yuki to Upper Yukon	15	9/19	10/28	39.1	10/24	32.6	2.3	28.1
Koyukuk River	18	8/27	9/19	22.6	9/11	34.9	1.1	32.8
Tanana River	132	9/6	11/18	72.3	10/6	34.0	0.4	33.2
Upper Yukon	NA	NA	NA	NA	NA	NA	NA	NA

Note: Only includes fish fates designated as spawner. Mean travel rate includes a 95% confidence interval (95% CI). MS means mainstem Yukon River. NA means not applicable.

Table 5.–Mean migration rate (km/day), between release or tower locations for coho salmon captured at Russian Mission and designated as spawners, 2022.

From	To	n	Mean (km/day)	SD	SE	95% CI (±)
Release	Paimiut	133	29.7	9.2	0.8	28.1
Release	MS Anvik [a]	54	33.6	7.0	1.0	31.7
Release	Anvik River [a]	20	24.1	7.1	1.6	21.0
Release	MS-Yuki [a]	8	34.6	3.6	1.3	32.2
Release	Nenana [a]	1	28.2	NA	NA	NA
Paimiut	MS Anvik	93	39.1	6.8	0.7	37.7
Paimiut	Anvik River	13	16.4	6.4	1.8	13.0
Paimiut	MS-Yuki [a]	5	33.3	9.8	4.4	24.7
MS Anvik	Lower Koyukuk	16	37.3	4.6	1.2	35.1
MS Anvik	MS-Yuki	77	34.7	10.8	1.2	32.3
MS-Yuki	Manley (U)	62	36.5	4.7	0.6	35.4
Manley (U)	Kantishna Gateway	26	31.5	8.5	1.7	28.2
Manley (U)	Nenana	59	29.4	5.3	0.7	28.1

Note: Mean travel rate includes a 95% confidence interval (95% CI). MS means mainstem Yukon River, and (U) means the name of the Upper tower. NA means not applicable.

[a] Includes fish that were not detected at sequential tower(s). Mean travel rate includes a 95% confidence interval (95% CI).

Table 6.–Summary of the nominated changes to the Anadromous Waters Catalog (AWC) that resulted from coho salmon radiotagging and tracking, 2022.

Name	AWC number	Result salmon present
Huslia River, Billy Hawk Creek, unnamed tributary	334-40-11000-2125-3171 (-4351) (-5030)	Adding new species and extending stream
Yukon River, unnamed tributary	334-40-11000-2311	Adding new species to stream
Ukawutni Creek	334-40-11000-2289	Adding new species to stream
Yuki River	334-40-11000-2230	Adding new species to stream
Unnamed tributary of Yuki River, unnamed tributary	334-40-11000-2230-3100	Adding new stream and new species
Ninemile River	334-35-11000-2083	Adding new species to stream
Nulato River, S. Fork Nulato River	334-35-11000-2091 (-3011)	Adding new stream and new species
Kaltag River	334-35-11000-2065	Adding new species and extending stream up drainage.
Stink Creek, unnamed tributary	334-35-11000-2025-3036	Adding new species to stream
Poison Creek	334-35-11000-2025-3002	Adding new species and extending stream up drainage.
Thompson Creek	334-30-11000-2851	Adding new life phase to stream
Grayling Creek	334-30-11000-2781	Adding new species and extending stream up drainage.
Anvik River	334-30-11000-2701	Extending upper reach for species
Anvik River, unnamed tributaries	334-30-11000-2701-3339 (-4007)	Adding new stream and new species
Runkles Creek, unnamed tributary	334-30-11000-2701-3171 (-4010)	Adding new stream and new species
Stuyahok River, unnamed tributary	334-30-11000-2651-3251 (-4050)	Adding new stream and new species
Yukon River, unnamed tributary	334-40-11000-2285	Adding new stream and new species
Bear Creek, unnamed tributary	334-35-11000-2005-3015	Adding new life phase to stream
Bonasila River, unnamed tributary	334-30-11000-2651-3360	Adding new life phase to stream

Table 7.–Genetic sample locations, number of samples currently in baseline, with life stage, and priority to fill data gaps for Yukon River coho salmon.

Population	Drainage	Region	N	Life stage	Priority	Comment
Archuelinguk River	Yukon	Lower	43	Adult	3	Supplement existing samples
Andreafsky River	Yukon	Lower	92	Adult	4	Supplement existing samples
Bonasila River	Yukon	Lower	–	Adult	4	Need for data gap if accessible
Anvik River	Yukon	Lower	45	Adult	3	Supplement existing samples
Thompson Creek	Yukon	Lower	–	Adult	4	Need for data gap if accessible
Rodo River	Yukon	Lower	46	Adult	3	Supplement existing samples
Kaltag River	Yukon	Lower	89	Adult	1	Supplement existing samples and accessible
Gisasa River	Koyukuk\Yukon	Lower	–	Adult	4	Need for data gap if accessible
Billy Hawk Creek	Huslia\Koyukuk\Yukon	Lower	–	Adult	2	Need for data gap to supplement Koyukuk River drainage
Clear Creek	Hogatza\Koyukuk\Yukon	Lower	46	Juvenile	2	Need adults to supplement Koyukuk River drainage
Yuki River	Yukon	Upper	–	Adult	1	Need for data gap
Tozitna River	Yukon	Upper	–	Adult	1	Need for data gap
Kantishna River	Tanana\Yukon	Upper	232	Adult	5	Do not need more at this time
Toklat River	Kantishna\Tanana\Yukon	Upper	–	Adult	2	Need for data gap to supplement Kantishna River drainage
Glacier Creek	Nenana\Tanana\Yukon	Upper	60	Adult	5	Do not need more at this time
Seventeenmile Slough	Nenana\Tanana\Yukon	Upper	137	Adult	5	Do not need more at this time
Otter Creek	Nenana\Tanana\Yukon	Upper	114	Adult	5	Do not need more at this time
Lignite Creek	Nenana\Tanana\Yukon	Upper	51	Adult	5	Do not need more at this time
Delta River	Tanana\Yukon	Upper	183	Adult	5	Do not need more at this time
Delta Clearwater River	Tanana\Yukon	Upper	95	Adult	3	Accessible and to supplement Tanana River drainage
Richardson Clearwater River	Tanana\Yukon	Upper	–	Adult	3	Accessible and to supplement Tanana River drainage
Kevinjik Creek	Porcupine\Yukon	Upper	102	Juvenile	1	Need for data gap and planned sampling
Old Crow Community	Porcupine\Yukon	Upper	148	Juvenile	3	Need adults if accessible to supplement Porcupine River drainage
Fishing Branch River	Porcupine\Yukon	Upper	111	Juvenile	5	Do not need more at this time

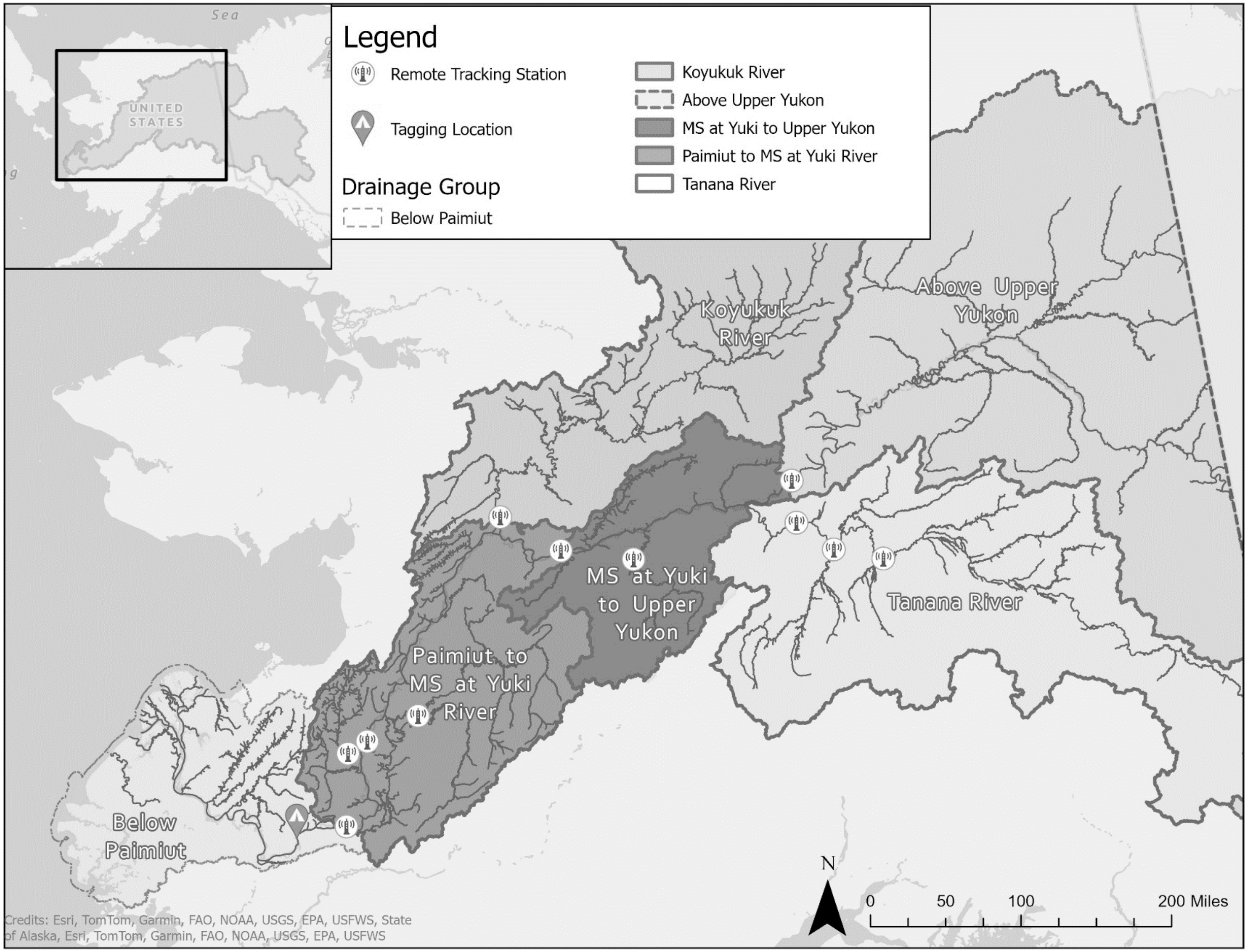


Figure 1.–Yukon River drainage showing coho salmon monitoring projects, tagging site, and emote tracking stations, 2022.

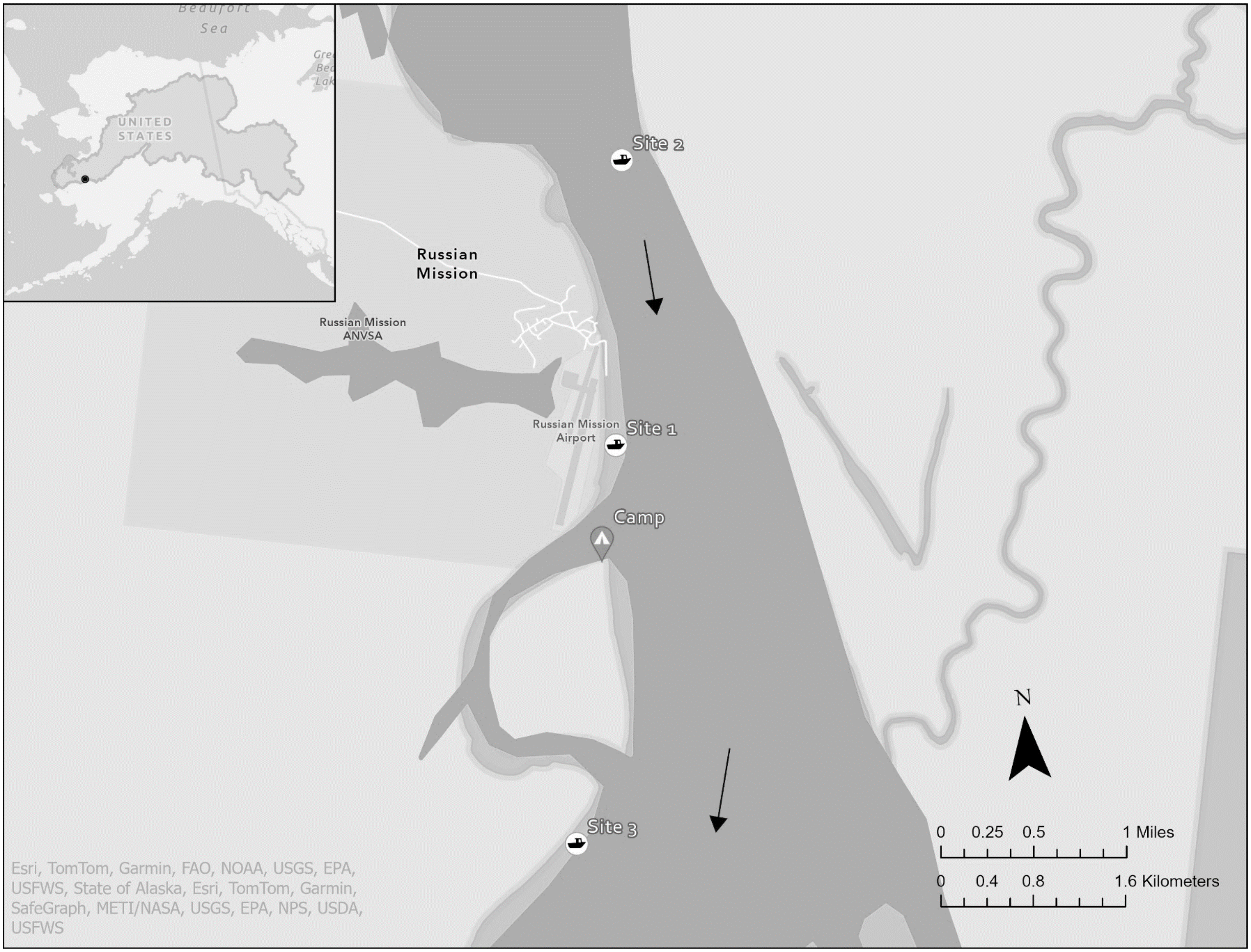


Figure 2.–Coho salmon tagging location with drift sites 1–3 indicated, Yukon River at Russian Mission, 2022.

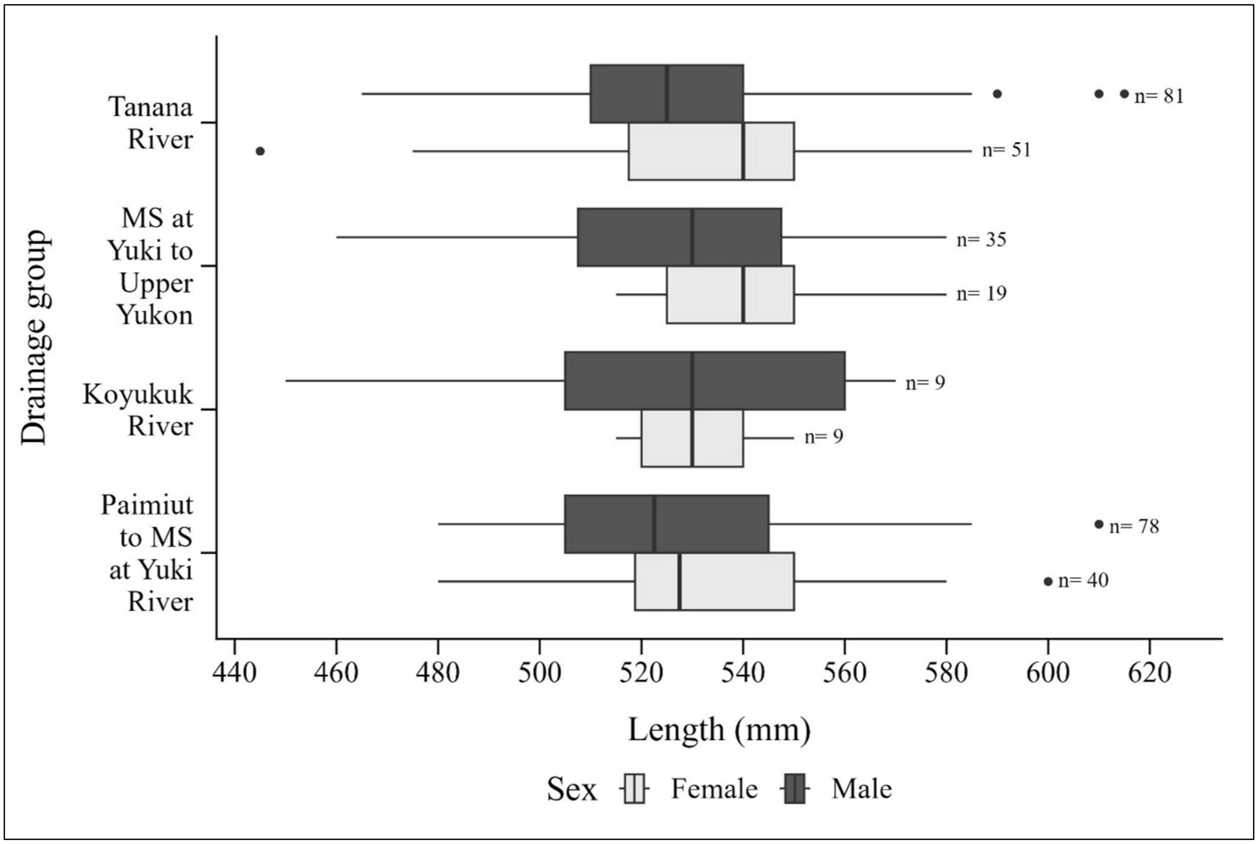


Figure 3.–Length (mid eye to fork of tail) distribution by drainage group for tagged female and male coho salmon, 2022.

Note: Horizontal lines represent minimums and maximums, shaded areas represent 25% to 75%, vertical lines within boxes represent the median, and dots indicate outliers. MS means mainstem Yukon River.

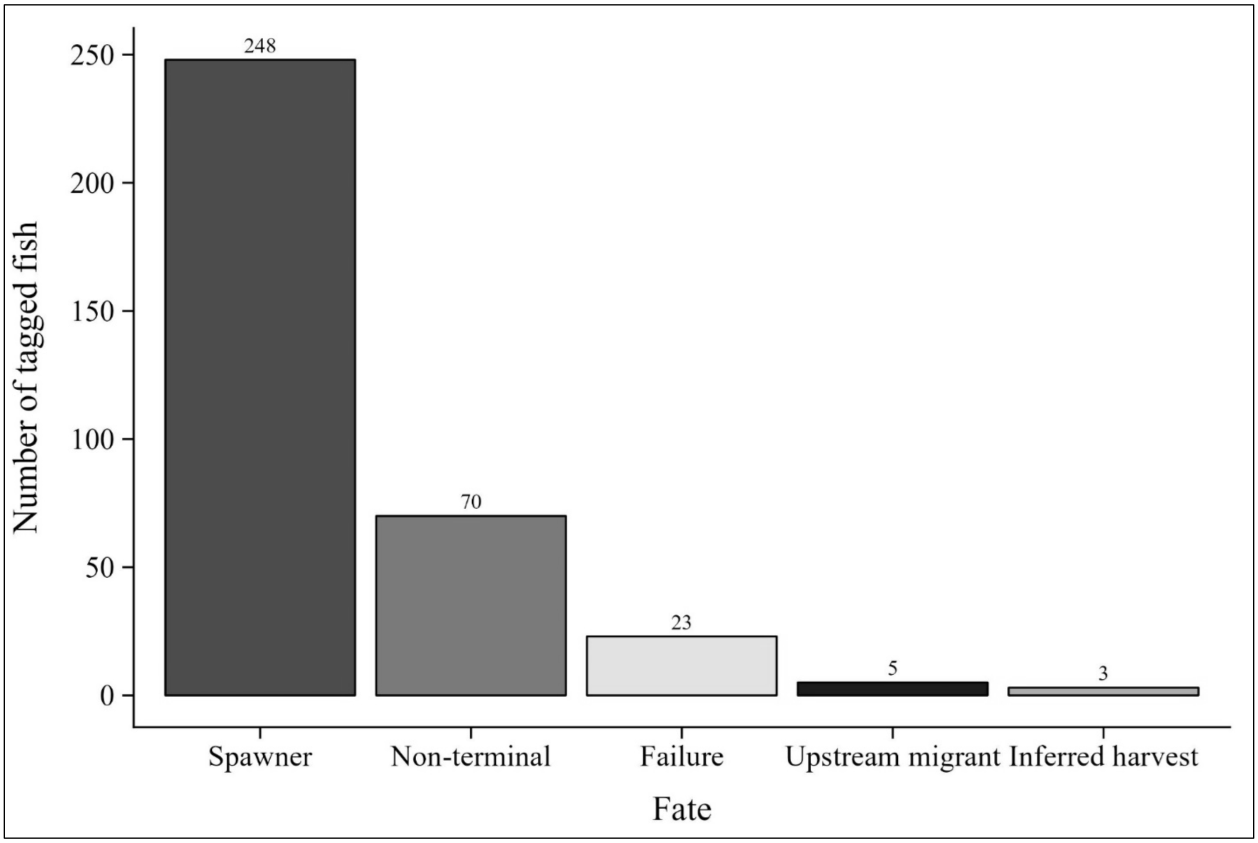


Figure 4.–Number of tagged coho salmon assigned to final fate categories, 2022.

Note: The following fates were assigned to tagged fish: spawners are fish located in a tributary, non-terminal are fish that remained in proximity of the Yukon River mainstem, failure indicates a fish did not migrate into the study area, upstream migrant included fish that entered the study area but were never found again, and some fish were inferred as harvested. The total numbers of tagged coho salmon assigned to each fate are located above each bar.

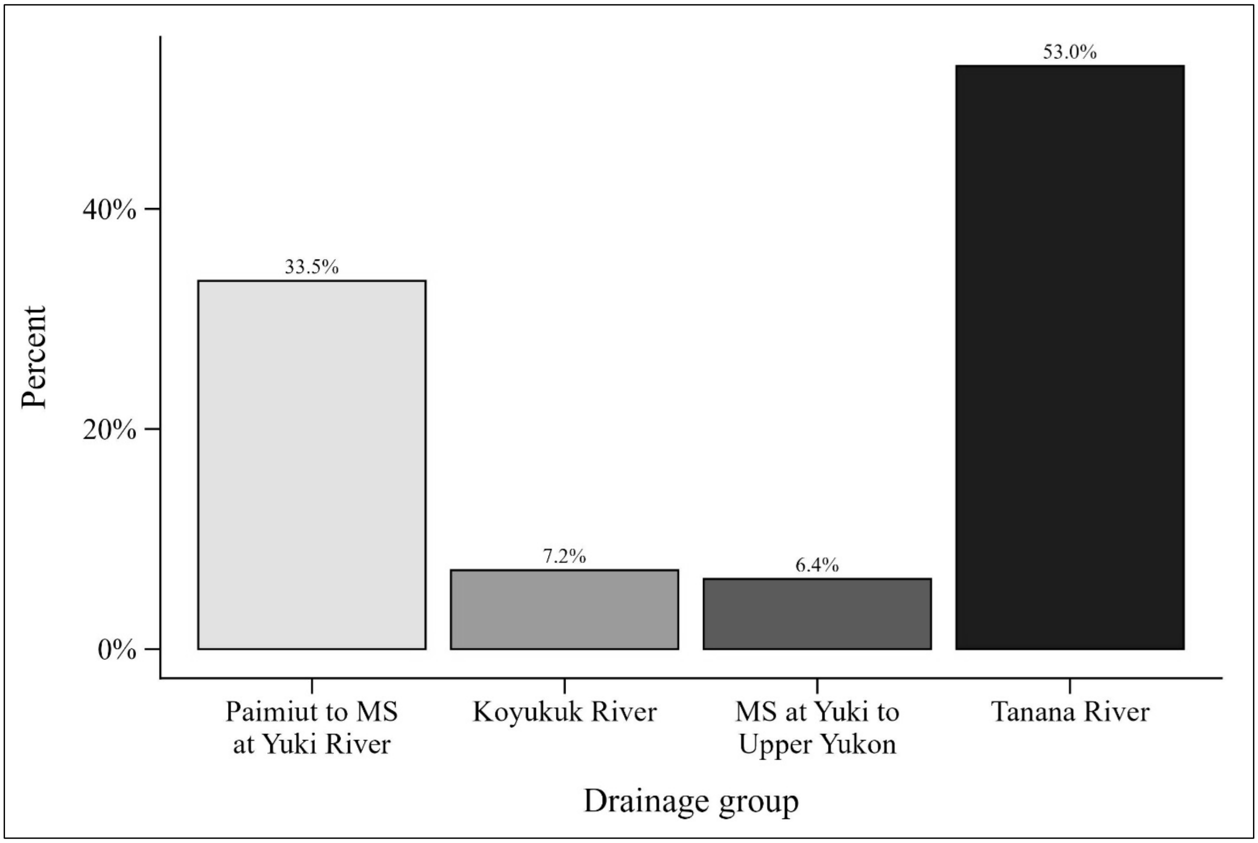


Figure 5.–Relative percent of coho salmon returning to each drainage group encountered at the tagging site near Russian Mission, 2022.

Note: MS means mainstem Yukon River. Only includes fish designated as a spawner.

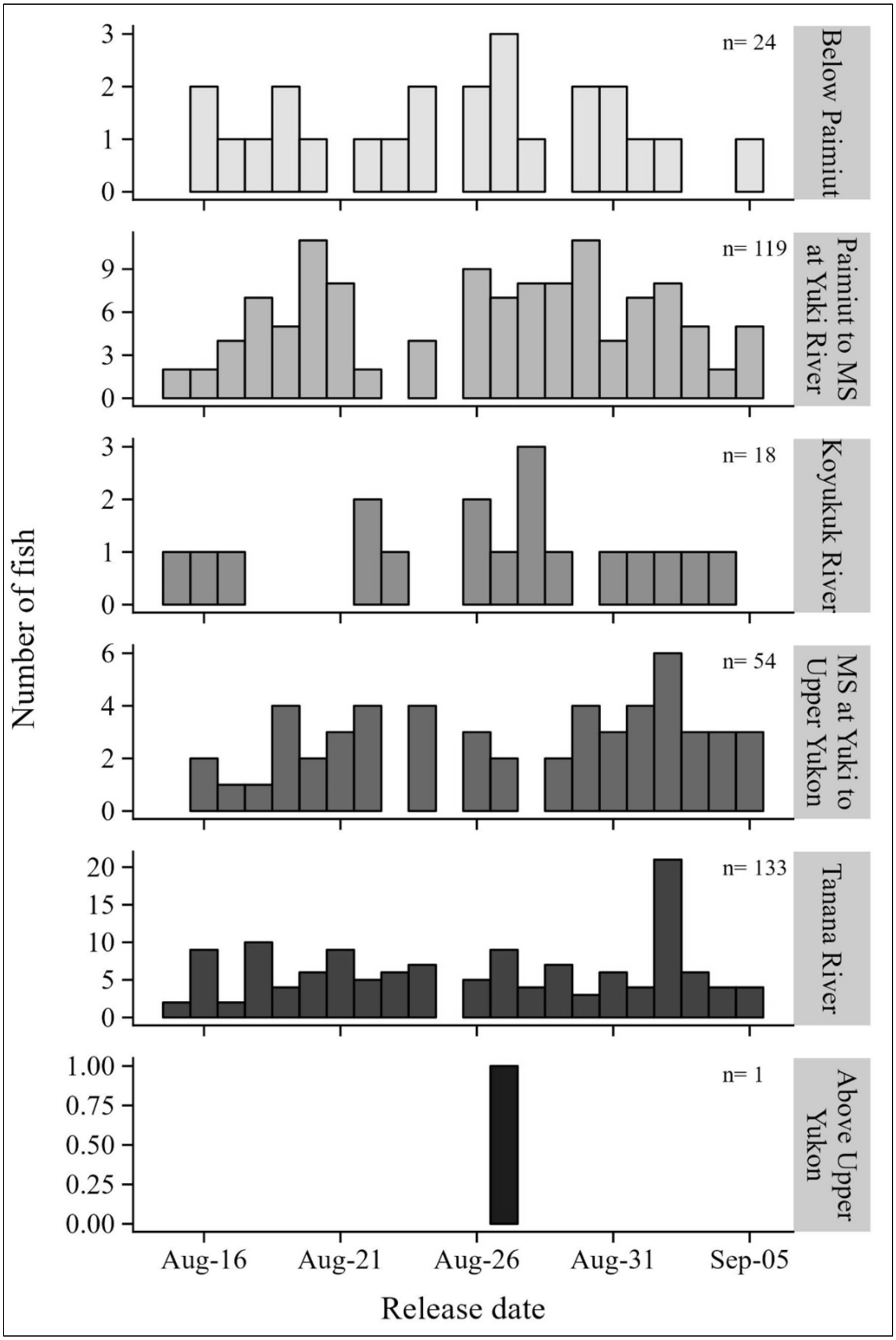


Figure 6.–Total daily number of fish tagged from each drainage group, including those that moved downstream from Russian Mission, 2022.

Note: The figures have different *y*-axis scales. MS means mainstem Yukon River.

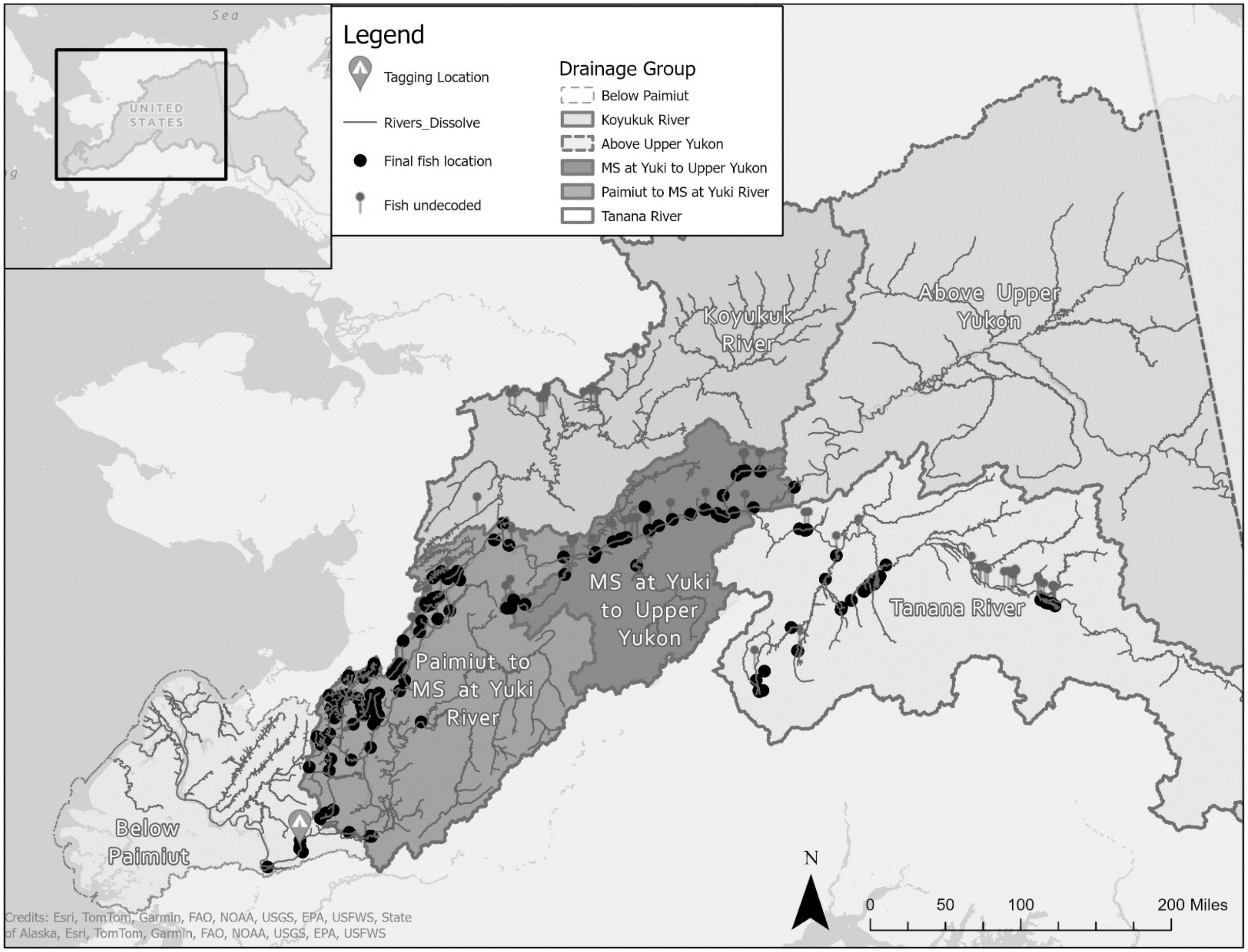


Figure 7.–Yukon River drainage showing the last known location of tagged coho salmon, 2022.

Note: MS means mainstem Yukon River.

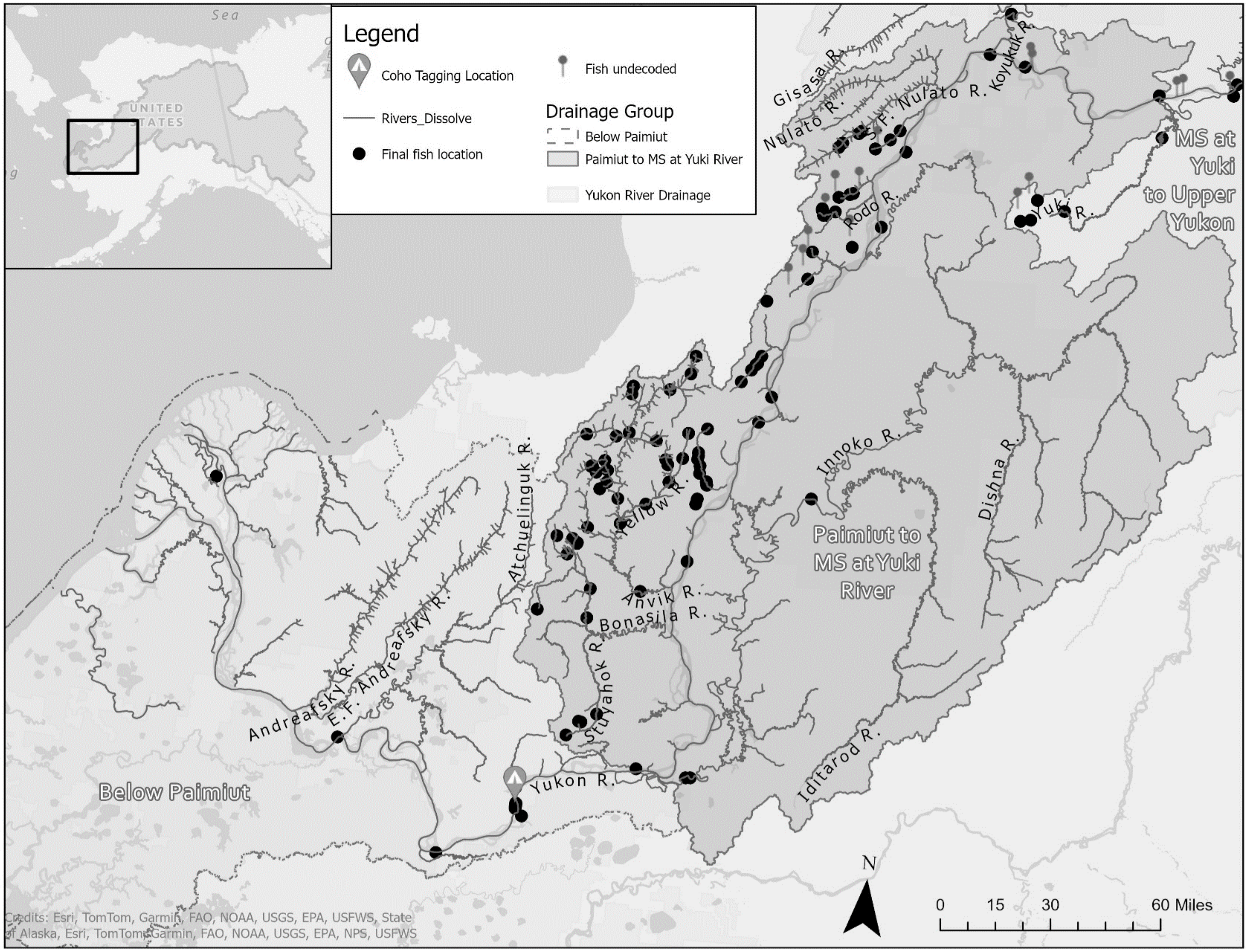


Figure 8.–Final locations of tagged coho salmon within the Yukon River between Paimiut to Mainstem Yuki drainage group, 2022.

Note: MS means mainstem Yukon River.

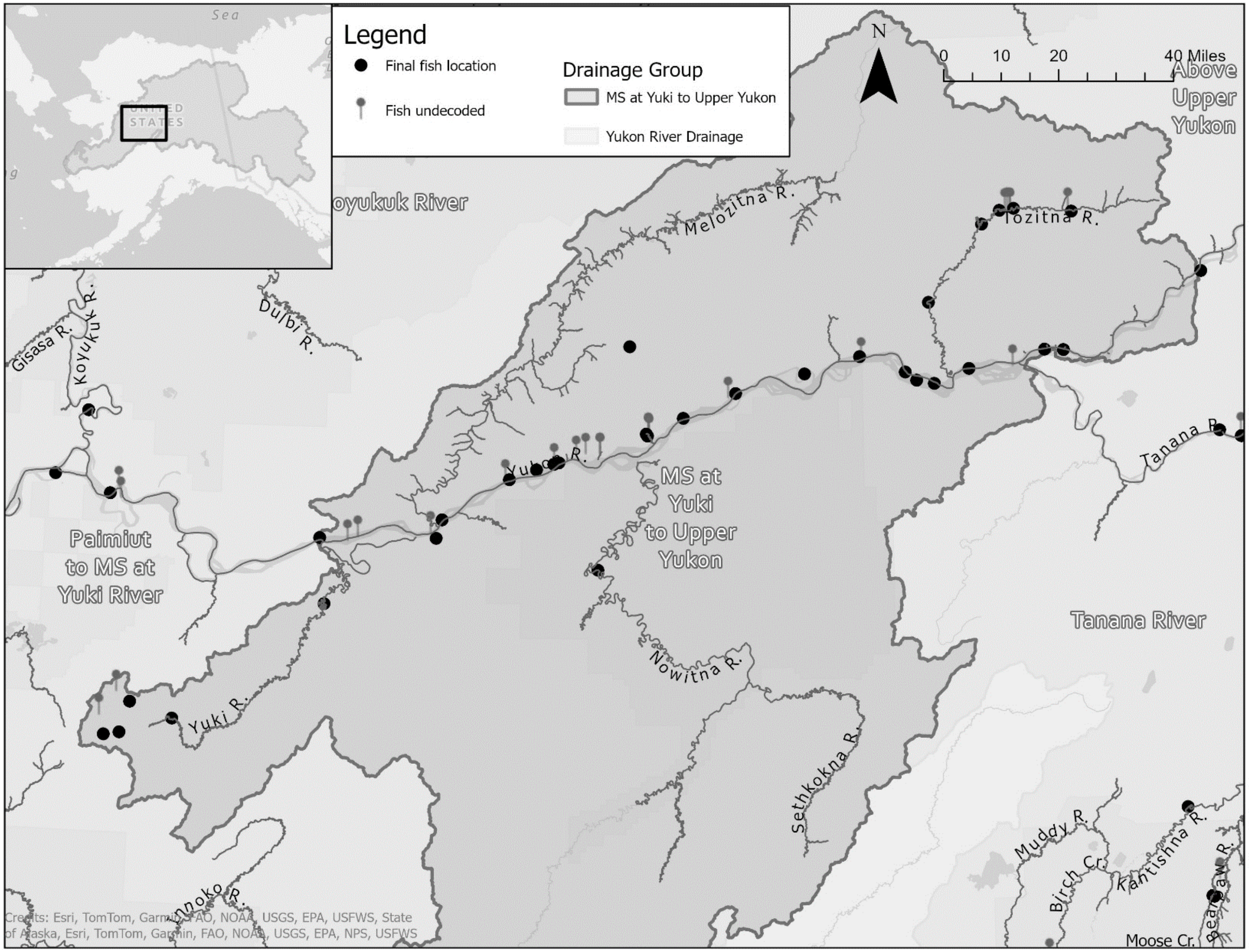


Figure 9.–Final locations of tagged coho salmon within the Yukon River between the mainstem Yuki to Upper Yukon River drainage group, 2022.

Note: MS means mainstem Yukon River.

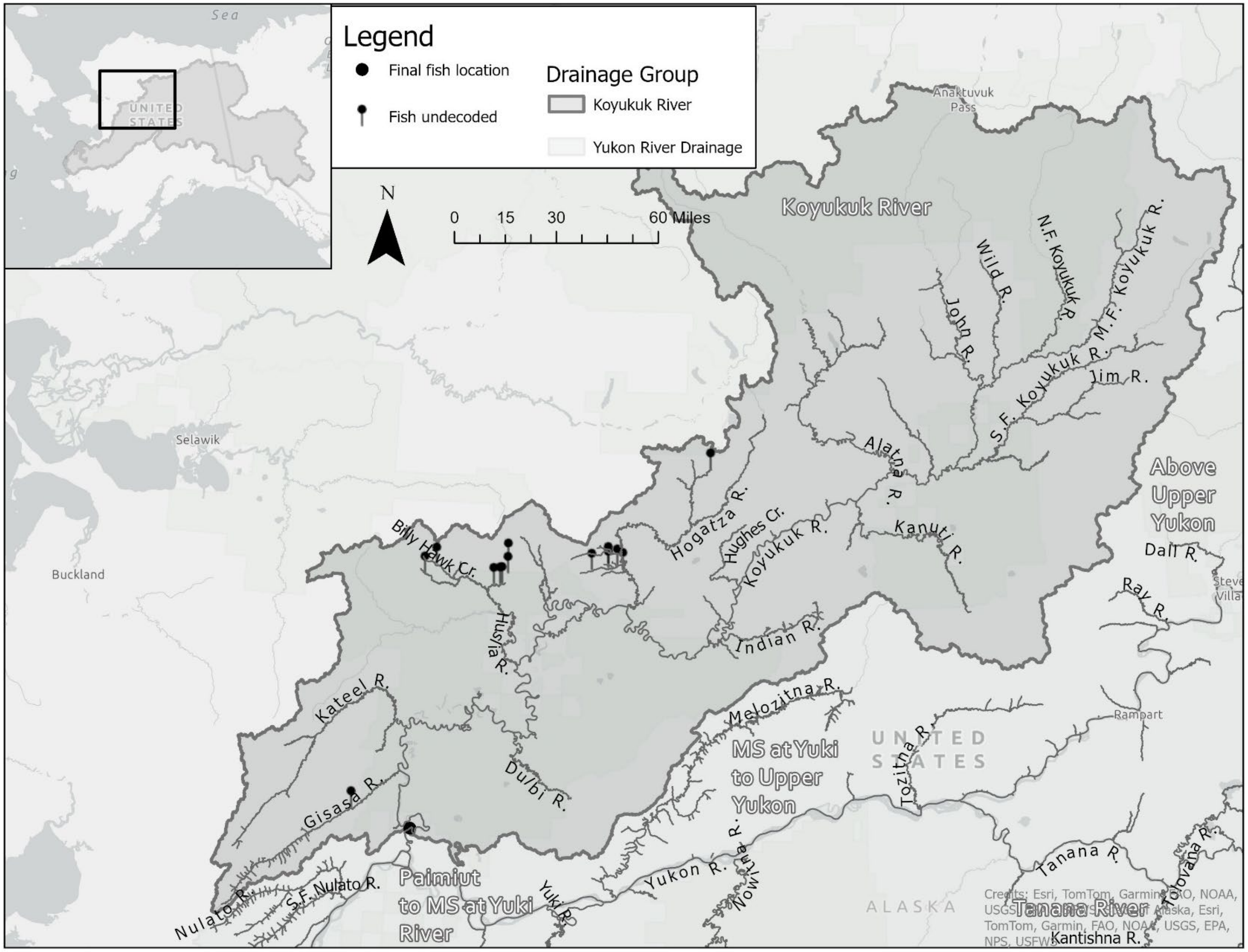


Figure 10.–Final locations of tagged coho salmon within the Koyukuk River drainage group, 2022.

Note: MS means mainstem Yukon River.

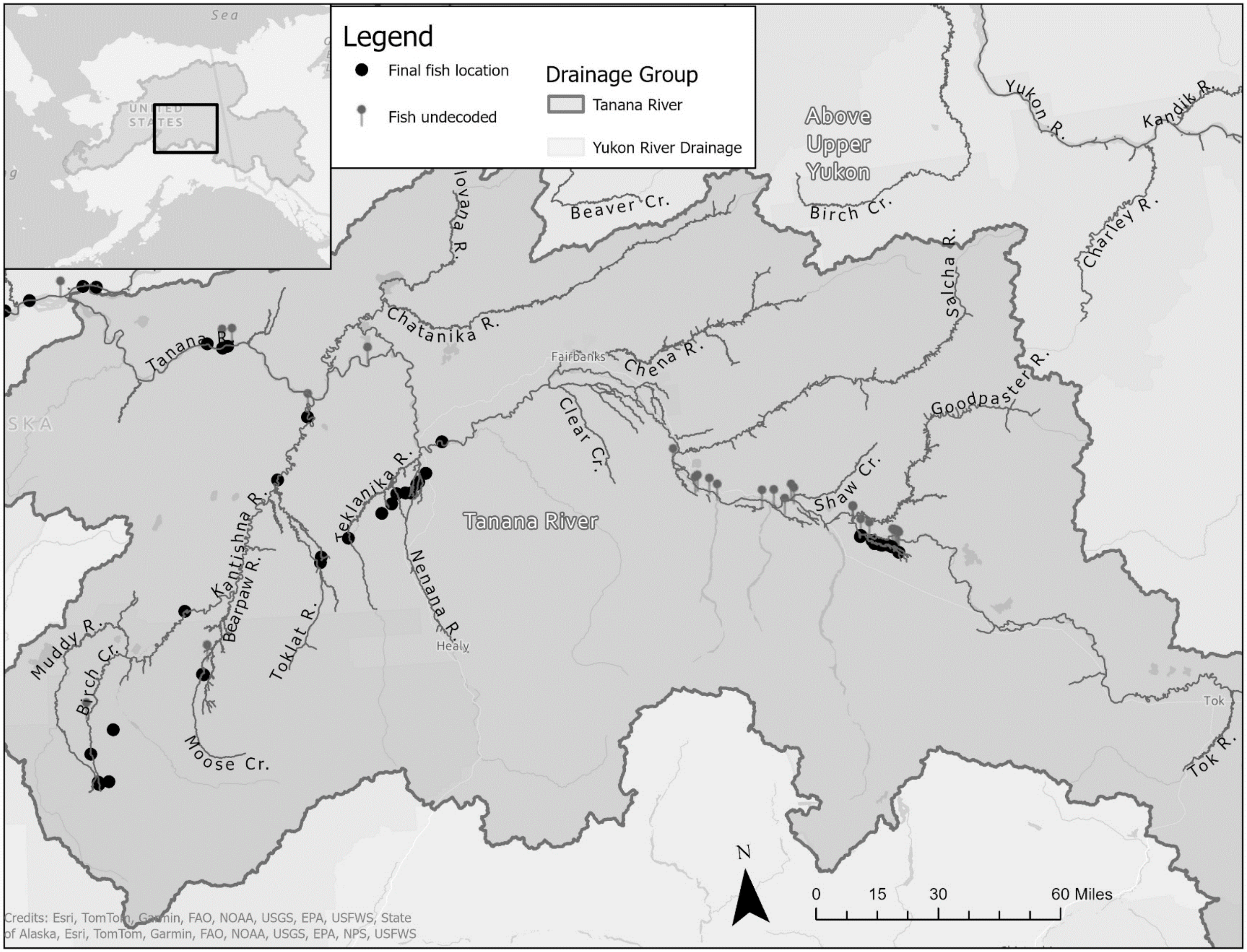


Figure 11.–Final locations of tagged coho salmon within the Tanana River drainage group, 2022.

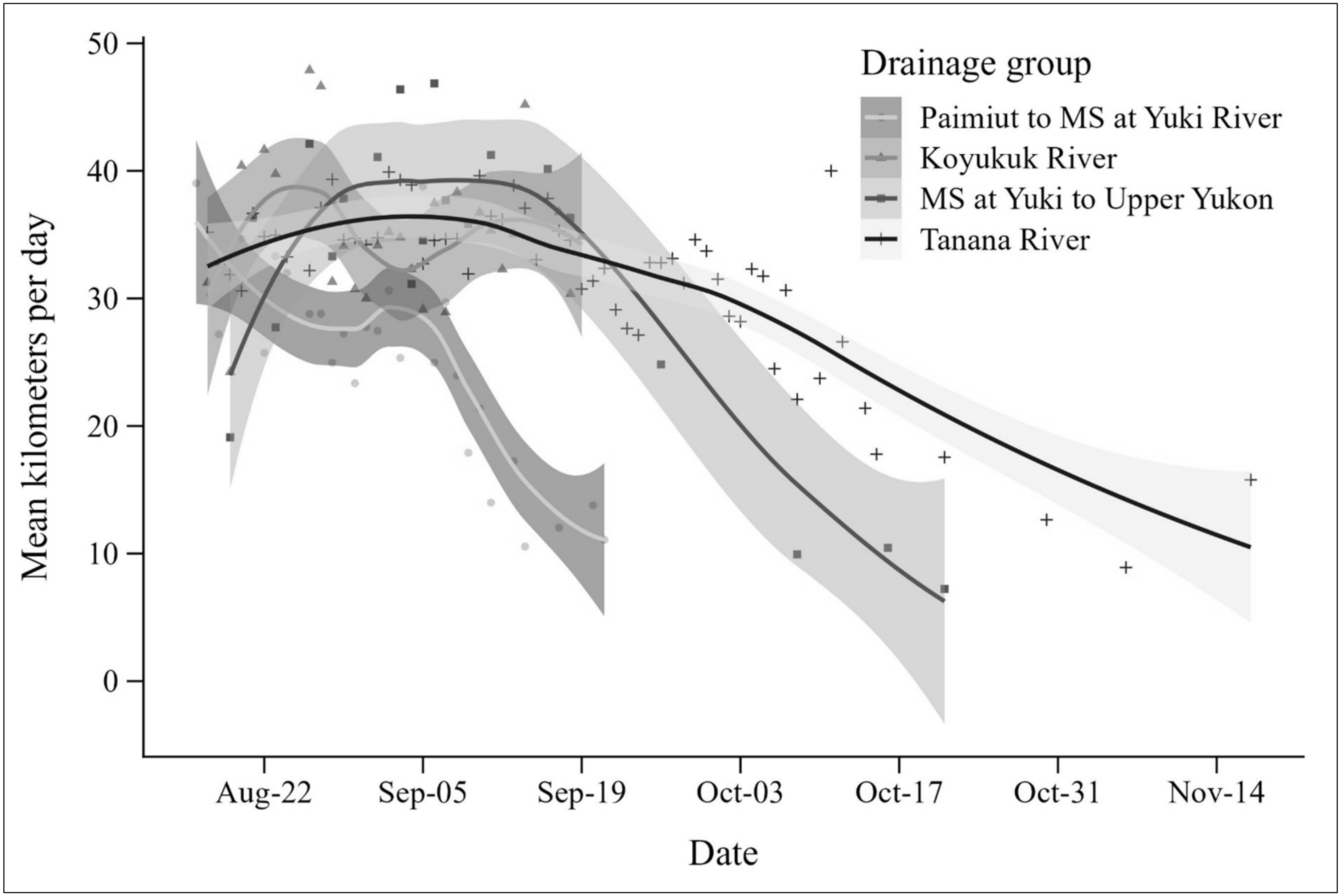


Figure 12.–Movement rates (km/day) with mean migration dates (dots; line – Loess smoother) and confidence intervals (95%; shaded area), for radiotagged coho salmon by drainage group migrating up the Yukon River, 2022.

Note: MS indicates mainstem Yukon River.

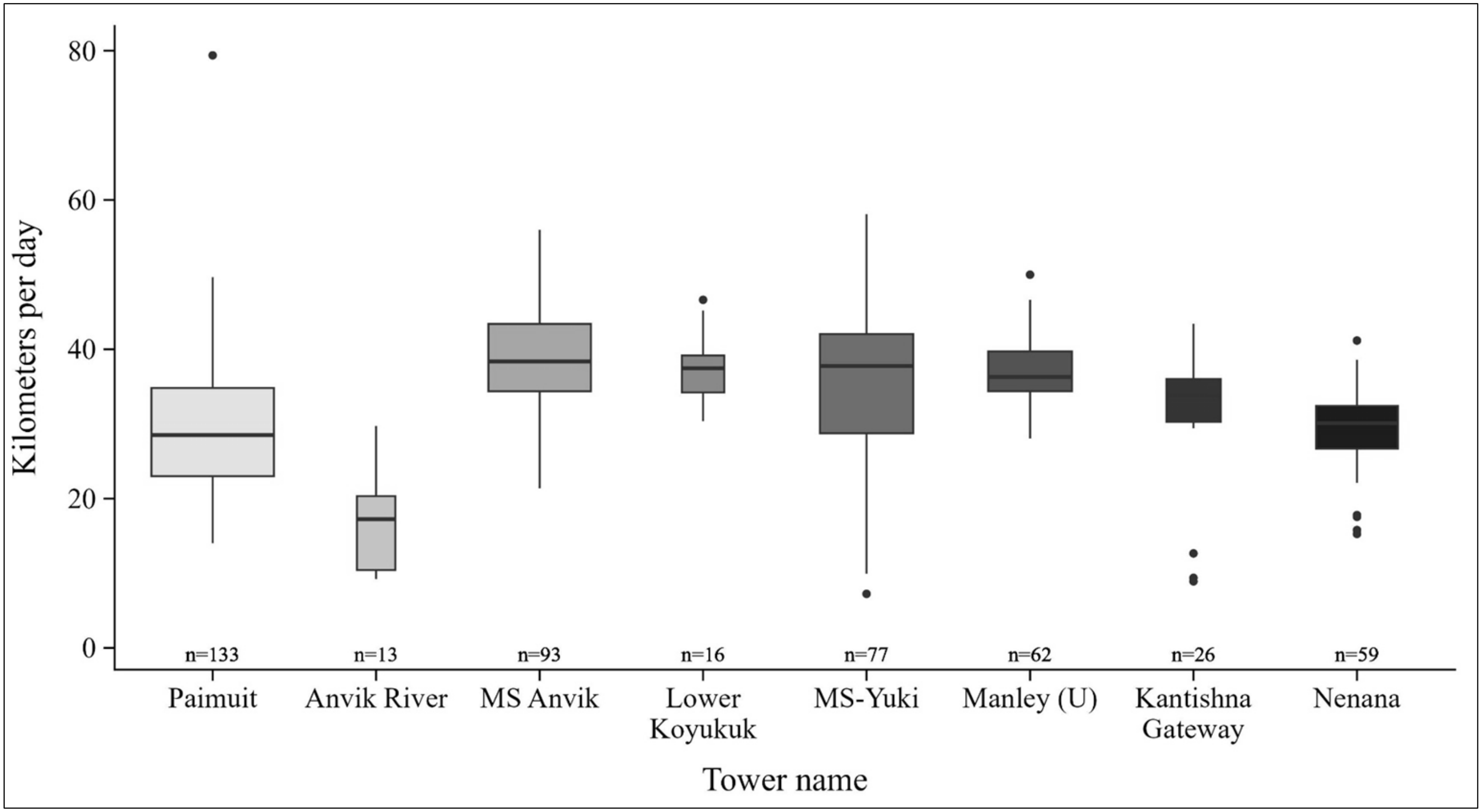


Figure 13.–Migration time between Paimiut tower and successive towers, excluding those that only passed 1 fish (Innoko, Nowitna, and Raven Ridge), 2022.

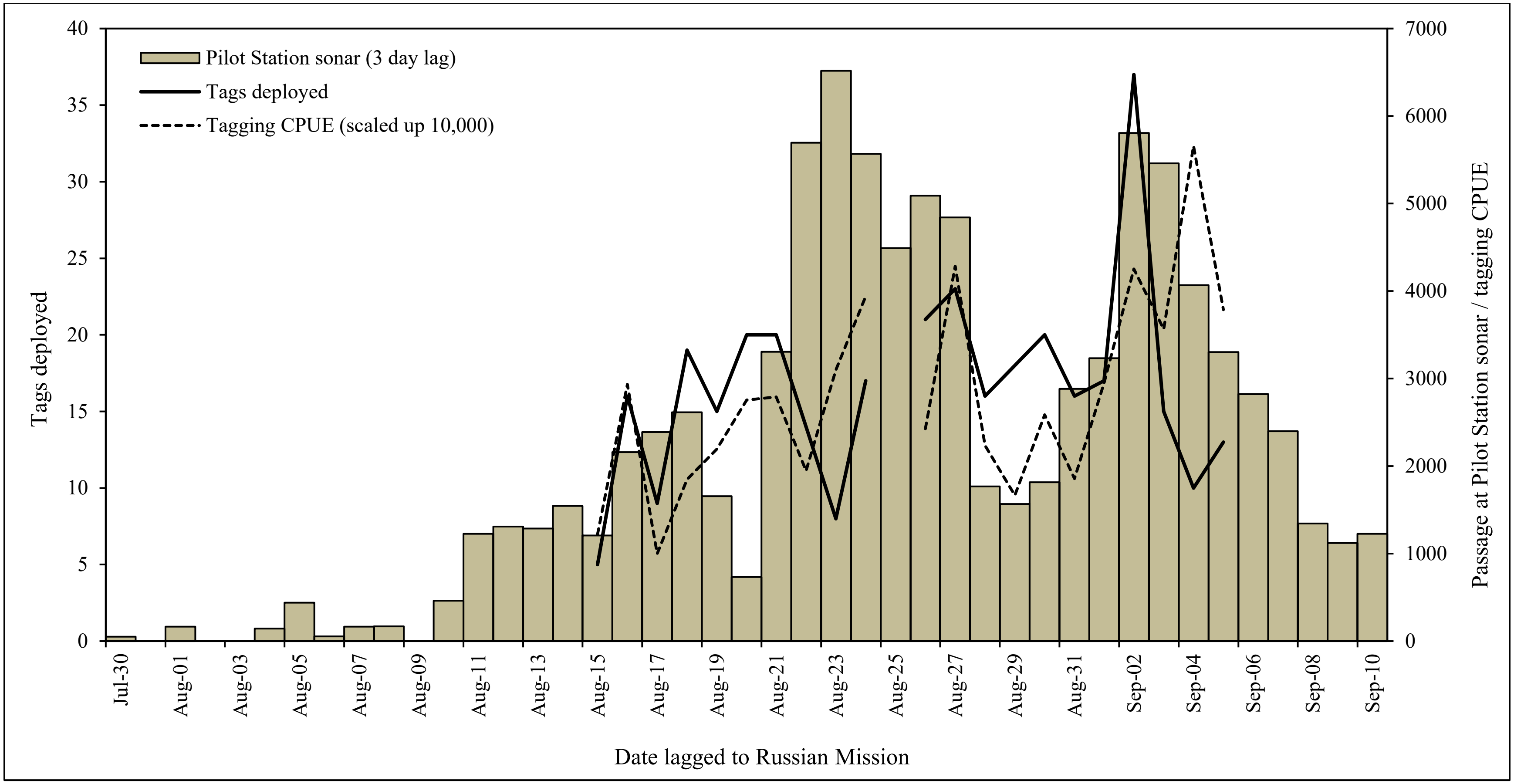
Note: MS means mainstem Yukon River, and (U) indicates Upper tower name. Vertical lines represent minimums and maximums, shaded areas represent 25% to 75%, horizontal lines within boxes represent the median, and dots represent outliers.

APPENDIX A: SUPPLEMENTAL PROJECT INFORMATION

Appendix A1.–Deployment rate of radio transmitters, based on historical run timing and daily passage estimates from the Pilot Station sonar, for coho salmon captured by drift gillnet near Russian Mission, 2022.

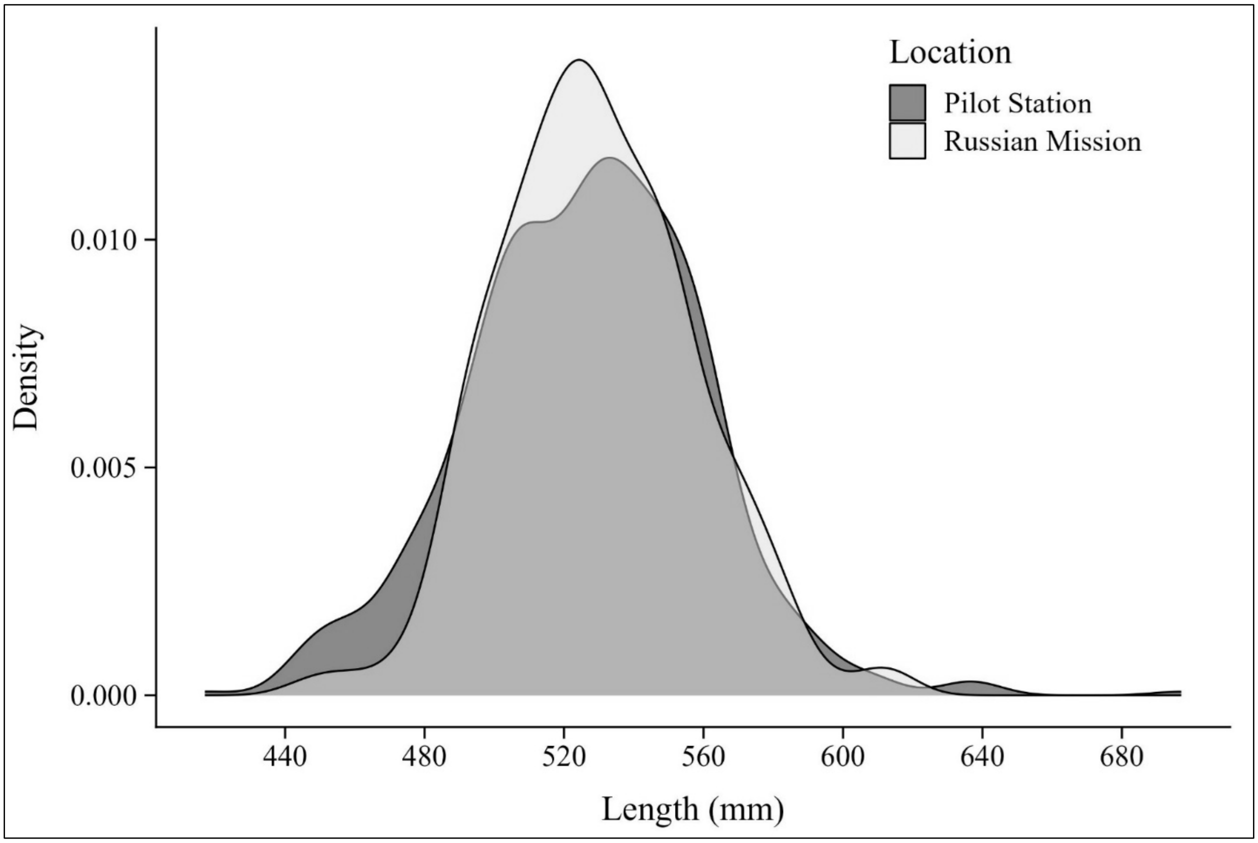
Date	Tags deployed	Tags deployed per week
8/13	–	
8/14	–	
8/15	5	
8/16	16	
8/17	9	
8/18	19	
8/19	15	64
8/20	20	
8/21	20	
8/22	14	
8/23	8	
8/24	17	
8/25		
8/26	21	100
8/27	23	
8/28	16	
8/29	18	
8/30	20	
8/31	16	
9/1	17	
9/2	37	147
9/3	15	
9/4	10	
9/5	13	
9/6	–	
9/7		38
Total	349	349

Appendix A2.–Daily tag deployment, number of fish caught per fathom-hour of fishing (scaled catch per unit effort [CPUE]) and estimated coho salmon passage at the Pilot Station sonar, 2022.



Note: It takes coho salmon about 3 days to migrate from the Pilot Station sonar site to the tagging site at Russian Mission; therefore, passage estimates are lagged forward 3 days for comparison with tagging data.

Appendix A3.–Density of coho salmon lengths (mid eye to fork of tail) comparing closest meshes at Pilot Station sonar project to the meshes used to captured and tag fish near Russian Mission, 2022.



Note: Mesh sizes from Pilot Station, 5.0 and 5.75 inch, were selected for comparison to tagging mesh sizes used of 5.5 and 6.0 inch.

Appendix A4.–Name, distance from the tagging site near Russian Mission, and the coordinates for each remote tracking station used to locate tagged coho salmon, 2022.

Tower name	Distance from tagging site (km)	Latitude	Longitude
Paimiut	64.8	61.961	-160.345
MS Anvik	201.3	62.789	-160.076
Anvik River	211.7	62.654	-160.453
Innoko	331.9	63.073	-159.052
Lower Koyukuk	530.9	65.022	-157.541
MS-Yuki	605.2	64.726	-156.144
Nowitna	798.9	64.658	-154.506
Raven Ridge	902.8	65.381	-150.891
Manley (U)	931.2	64.979	-150.823
Kantishna Gateway	1,003.2	64.701	-150.020
Nenana	1,110.3	64.582	-148.924

Note: MS indicates mainstem Yukon River and (U) indicates Upper tower name.

Appendix A5.–Descriptions of aerial and boat survey dates and routes during the surveys of tagged coho salmon, 2022.

Survey description	Method	Survey date
Yukon mainstem, Russian Mission to Rapids and Manley	Fixed-wing	9/6/22
Yukon mainstem, Russian Mission to Rapids and Manley	Fixed-wing	9/19/22
Bonasila and Anvik River Tributaries	Fixed-wing	9/27/22
Delta Clearwater River boat Lauch to River Mile 18	Boat survey	10/11/22
Delta Clearwater River boat Lauch to River Mile 18	Boat survey	10/20/22
Melozitna and Tozitna rover drainages	Fixed-wing	10/24/22
Lower Innoko River to Marshall	Fixed-wing	10/21/22
Sushana Creek, Geiger Creek and Toklat River spawning areas	Helicopter	10/25/22
17 Mile Slough, Julius Creek to Lignite Creek	Helicopter	10/26/22
Delta Clearwater River mouth river mile 0 to river mile 18	Boat survey	10/26/22
Birch Creek, McKinley River, and Foraker River	Fixed-wing	10/27/22
Kantishna River, Bearpaw River to Birch Creek.	Fixed-wing	10/26/22
Kaltag Area, Nulato River, Yuki River	Fixed-wing	10/28/22
Tanana mainstem, Cosna, Baker Creek, Tolovana and Chatanika Rivers	Fixed-wing	10/29/22
Delta Clearwater River mouth river mile 0 to river mile 18	Boat survey	11/1/22
Richardson Clearwater, Delta Clearwater, Tok Rivers	Helicopter	11/9/22
Richardson Clearwater, Delta Clearwater Rivers	Helicopter	11/18/22
Yukon River mainstem	Fixed-wing	11/23/22
Koyukuk River drainage	Fixed-wing	11/29/22

Appendix A6.–Summary of stream timing for fish fate spawner that resulted from coho salmon radiotagging and tracking, Yukon River drainage, 2022.

Drainage/stream name	AWC number	n	First date	Last date	Duration
Paimiut Slough	334-30-11000-2422	2	10/20	10/20	0
Bonasila River	334-30-11000-2651	3	9/26	9/26	0
Stuyahok River	334-30-11000-2651-3251	2	9/26	9/26	0
Unknown Creek-4050	334-30-11000-2651-3251-4050	1	9/26	9/26	0
Jackson Creek	334-30-11000-2651-3351	1	9/26	9/26	0
Unknown Creek-3360	334-30-11000-2651-3360	1	9/26	9/26	0
Unknown Creek-3379	334-30-11000-2651-3379	1	9/26	9/26	0
Anvik River	334-30-11000-2701	10	8/25	9/26	32
Short Creek	334-30-11000-2701-3095-4051	1	9/26	9/26	0
Yellow River	334-30-11000-2701-3120	3	9/26	9/26	0
Unknown Creek-4181	334-30-11000-2701-3120-4181	1	9/26	9/26	0
Unknown Creek-5049	334-30-11000-2701-3120-4181-5049	1	9/26	9/26	0
Yellow River	334-30-11000-2701-3120-4251	1	9/26	9/26	0
Swift River	334-30-11000-2701-3211	2	9/26	9/26	0
Unknown Creek-4031	334-30-11000-2701-3211-4031	1	9/26	9/26	0
Swift River	334-30-11000-2701-3211-4041	1	9/26	9/26	0
Unknown Creek-5020	334-30-11000-2701-3211-4051-5020	1	9/26	9/26	0
Swift River	334-30-11000-2701-3211-4058	1	9/26	9/26	0
Otter Creek	334-30-11000-2701-3299-4015-5018	1	9/26	9/26	0
Otter Creek	334-30-11000-2701-3299-4050	1	9/26	9/26	0
Canyon Creek	334-30-11000-2701-3300-4056	1	9/26	9/26	0
Unknown Creek-3315	334-30-11000-2701-3315	1	9/26	9/26	0
Unknown Creek-4007	334-30-11000-2701-3339-4007	2	9/26	9/26	0
Unknown Creek-5015	334-30-11000-2701-3339-4007-5015	1	9/26	9/26	0
Unknown Creek-3419	334-30-11000-2701-3419	1	9/26	9/26	0
Unknown Creek-4007	334-30-11000-2701-3471-4007	1	9/26	9/26	0
Thompson Creek	334-30-11000-2851	10	9/26	9/26	0
Unknown Creek-3015	334-35-11000-2005-3015	5	9/26	9/26	0
Stink Creek	334-35-11000-2025	1	10/27	10/27	0
Unknown Creek-3012	334-35-11000-2025-3012	1	10/27	10/27	0
Rodo River	334-35-11000-2055	1	10/27	10/27	0
Unknown Creek-3070	334-35-11000-2055-3070	3	10/27	10/27	0
Kaltag River	334-35-11000-2065	1	10/27	10/27	0
Unknown Creek-3040	334-35-11000-2065-3040	1	10/27	10/27	0
Ninemile River	334-35-11000-2083	3	10/27	10/27	0
South Fork Nulato River	334-35-11000-2091-3011	2	10/27	10/27	0
Unknown Creek-4174	334-35-11000-2091-3011-4174	1	10/27	10/27	0
Unknown Creek-4182	334-35-11000-2091-3011-4182	1	10/27	10/27	0
Yukon River	334-40-11000	2	9/18	10/28	40
Koyukuk River	334-40-11000-2125	18	8/27	9/19	23
Yuki River	334-40-11000-2230	2	10/27	10/27	0
Unknown Creek-2311	334-40-11000-2311	2	10/28	10/28	0
Tozitna River	334-40-11000-2445	4	10/23	10/23	0
Dagislakhna Creek	334-40-11000-2445-3091	1	10/23	10/23	0

-continued-

Appendix A6.–Page 2 of 2.

Drainage/stream name	AWC number	n	First date	Last date	Duration
Tanana River	334-40-11000-2490	84	9/6	11/17	72
Kantishna River	334-40-11000-2490-3140	17	9/12	11/6	55
Barton Creek	334-40-11000-2490-3140-4065-5025	1	10/24	10/24	0
Unknown Creek-6040	334-40-11000-2490-3140-4065-5025-6040	1	10/24	10/24	0
Moose Creek	334-40-11000-2490-3140-4115-5044	2	10/27	10/27	0
Birch Creek	334-40-11000-2490-3140-4146	1	10/26	10/26	0
Hult Creek	334-40-11000-2490-3140-4146-5700	2	10/26	10/26	0
Nenana River	334-40-11000-2490-3200	1	10/25	10/25	0
Lost Slough	334-40-11000-2490-3200-4011-5117	2	10/27	10/27	0
Seventeenmile Slough	334-40-11000-2490-3200-4011-5141	1	10/25	10/25	0
Teklanika River	334-40-11000-2490-3200-4028	1	10/27	10/27	0
Unknown Creek-3412	334-40-11000-2490-3412	2	10/19	11/17	29
Clearwater Creek	334-40-11000-2490-3416	3	10/10	11/17	38
One Mile Slough	334-40-11000-2490-3416-4005	1	10/31	10/31	0
Tanana River	334-40-11000-2490-3416-4005	1	11/8	11/8	0
Parker Spring	334-40-11000-2490-3416-4011	1	10/25	10/25	0
Unknown Creek-4012	334-40-11000-2490-3416-4012	2	10/19	11/17	29
Clearwater Creek	334-40-11000-2490-3416-4020-5010	1	11/17	11/17	0
Granite Creek	334-40-11000-2490-3416-4020-5020	1	10/10	10/10	0
Unknown Creek-	N/A	21	9/26	10/27	31

Note: AWC refers to the Anadromous Waters Catalog.